Les ressources de pêche de l'Adriatique : situation et perspectives

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La mer Adriatique s'étend en direction N.O./S.E. sur 700 Km et plus, tandis que la distance entre Pescara (côte italienne) et Spalato (côte dalmate) est à peu près de 200 km. La surface occupée par l'Adriatique est de 138.000 km², c'est-à-dire 1/125 de la Mé diterranée entière.

Si les ressources étaient distribuées uniformément, en considérant la production totale de la Méditerranée comme 1.000.000 de tonnes/année, les prises annuelles de l'Adriatique devraient atteindre les 50.000 tonnes. En fait elles sont cinq fois plus élevées.

Cela est dû à la très grande productivité primaire et paraprimaire, à la fois déterminée par les apports terrigènes des fleuves qui débouchent en Adriatique, surtout du côté italien et à l'extension du plateau continental.

A peu près 1/3 de la totalité des eaux continentales méditerranéennes débouchent dans les bassins Nord et central de l'Adriatique. Un rapport direct existe entre eutrophisation et niveau de la production halieutique. Espèces qui sont présentes dans toutes les mers italiennes, seulement en Adriatique constituent des véritables communautés exploitables. C'est le cas de la plupart des mollusques bivalves benthiques détritivores et sestonophages.

La contribution de l'Adriatique à la production halieutique italienne dépasse les 55%, dont 48% viennent de l'Adriatique septentrionale et centrale. Toutefois le pourcentage de contribution a baissé lors de ces dix dernières années.

La chute des prises globales ou la réduction des captures par unité d'effort concernent les stocks des bivalves, par exemple la petite praire (*Chamelea gallina*), la coquille Saint-Jacques (*Pecten jacobaeus*) ,etc., et les stocks des poissons démersaux. L'appauvrissement est lié probablement à différents facteurs : d'un côté l'augmentation de l'effort de pêche qui, pendant ces vingt dernières années a triplé sur les bivalves côtiers et doublé sur les poissons; de l'autre côté la mortalité "naturelle" accrue par les vastes anoxies qui ont affecté les fonds de l'Adriatique Nord et centrale. Pour ce qui concerne les petites espèces pélagiques, l'évaluation des stocks par méthodologies acoustiques a enregistré la collapse du stock d'anchois après 1986 et seulement pendant les années 1990-91 la situation a changé, avec une remontée partielle de la biomasse.

Par compensation biologique est tombée la biomasse des sardines et des autres pélagiques comme les chinchards (*Trachurus spp.*).

Le stock des sprats qui avait touché le minimum en 1988-89 a commencé sa remontée et se tient maintenant sur un niveau moyen.

Les fluctuations des petites espèces pélagiques semblent toutefois indépendantes de l'effort de pêche, qui d'ailleurs est resté à peu près constant. En manière prioritaire s'impose l'aménagement des ressources littorales, en particulier des bivalves côtiers et des stocks démersaux du plateau continental.

Etant donné la complexité des pêcheries méditerranéennes (stocks multispécifiques) il n'est pas possible d'aménager les ressources par TAC ou QUOTA. S'imposent donc des mesures techniques qui visent d'un coté à la reconstitution des stocks exploités (contrôle de l'effort de pêche, arrêt saisonnier, zones marines protégées etc.) et de l'autre côté à la valorisation de la bande côtière (installations conchylicoles, récifs artificiels, cages d'élevages, mariculture en géneral).

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The Albanian sea-coast problems and prospects

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The Albanian sea-coast includes the most eastern and southern parts of the Adriatic sea-shore and the north-eastern part of the Ionian sea-shore. It is little dissected and there are few caps and bays, and only one important island. The general length of the Albanian sea-coast is 450 km (excluding the coast line of the lagoons), from which 284 km belong to the Adriatic Sea. The main capes are: Rodoni, Bishti i Palles, Karaburuni; and the bays are those of Drini, Lalzi, Durres, Vlora, and Saranda.

1. The Albanian sea-coast is divided into two basic types from a geomorphological point of view : a) the low coast, mainly accumulative of the Adriatic Sea and b) the high rocky coast mainly corrosive of the Ionian Sea (KABO *et al.*,1990). The main geomorphological features of the Albanian Adriatic sea-coast with a S-N extension are : the presence of the beaches, the sands arrows and archs, lagoons, dunes and above all the presence of a highly expressed dynamic of the coast line. These features are mainly connected with the sincline structure that builds our Coast Lowland, and the solid deposits (53.250.000 tons/yr.) of the numerous rivers. The presence of the cliffs, the rocky capes, the gritty beaches, and a limited dynamic of the coast-line are the main features of the Ionian Sea with a SE-NW extension.These geomorphological features are connected with anticline structures, the calcareous formations, and the slight water flows (KABO, 1990).

2. The geomorphological classification is coherent with the geological one: a) there are some discernible characteristic zones of the Albanian Adriatic sea-coast like those of swampy accumulative (among the outfalls of the rivers), littoral sands, and radical rocks. In the last one, we can discern some sectors, like that of calcareous of Kretac (Shengjin); sandy-clays of Tortonian (Rodon) ; of alveolar-clays, and the sandy-conglomerations of Pliocen (Kavaje); of sandy-calcareous and clay-carbonics of Helvecen (Zvernec) (KONOMI, 1991); b) in the Ionian Sea sea-coast, we can evidence : the zone of carbonic rocks of Juras-Paleocene(Uji i Ftohte, Karaburun, Dhermi, Himare, Sarande) ; the zone of clay-alveolar sandy rocks of Oligocen and Akuitanian (Radhime, Piqeras, Lukove) and the zone of the friable proluvial-deluvial rocks (Orikum, Palase, Vrine) (KONOMI, 1991).

3. The littoral zone of Albania has its characteristic flora clearly differentiated from one area to another : a) *Ammophilia arenaria* and *Agropyron junceum* are the prevalent species of the dunes; b) *Halimione portulacoides* and *Halocnemum strobilaceum* are prevalent halophyle species of the salted lands; c) *Limonium* and *Cerithmum* are the prevalent species of the rocky coast of the Ionian Sea; d) the *Quercus ilicis* class of the mediterranean brushwoods vegetation is in the other rocky coast; e) the thermophyl downfall foliage plantations of the *Querceta pubescentis* class are in the hilly supermediterranean floor of the Adriatic. In the albanian coast many exotic species of the genera : *Eucaliptus Cupressus, Robinia,* etc. are cultivated, but the main aspect is formed by the coniferous forests, where the *Pinus halepnensis* is prevalent (Divjak, Poro etc .) (VANGJELI, 1991).

4. The outer geomorphology of the coast is coherent with its inner topography; the isobats of the corrosive zone are near the coast line, whereas they go away in the accumulative zone. There are three evident belts of the Adriatic shelf : a) the littoral shallow (0-50 m) mainly with sandy sediments ; b) the flat shelf lowland (50-100m) with sandy-aleuritic sediments ; c) the shelf slanting lowland (100-200m) with aleuritic and aleuritic-deltic sediments (PAPA, 1985).

5. Among the hydrological caracteristics of the albanian coast, we can mention : a) the values of the temperature of the superficial waters : perennial average value 19.2°C (Saranda) and 17.7°C (Shengjin); the highest value 29.8°C and the lowest value 7.7°C; b) the water salinity 30% -39.1% ; c) the tide amplitude 20-30 cm; d) the waves' height can reach up to 3 - 5 m in the bays and 9 - 8 m in the open sea ; e) the currents follow a South to North direction (PANO *et al.* , 1990).

6. Biogeographically, the albanian coast presents a special importance in the Mediterranean basin. The biological studies of our coast are limited. Up to now 131 species of multicellular algae, 251 species of fish, 46 species of echinoderms, 104 decapod species, 84 species of molluscs, etc... have been identified. (GJIKNURI *et al.* 1991). The presence on our coast, of such species of fish as : *Luvarus imperialis. Ranzania laevis, Coelorhinchus coelorhinchus, Lebistes reticulatus* (RAKA *et al.* 1991); of the algae *Fucus virsoides,Tenarea undulosa, Acetabularia parvula* ; of the echinoderms *Ophidiaster ophidianus, Holothuria helleri* and of the mollusc *Charonia seguenziae* completes their known spread in the Mediterranean.

7. Generally, the albanian coast is nonpolluted and includes several virgin areas. There is no record of mucus aggregates mucilage up to now. Nevertheless, there are some problems caused by human activity such as : the pollution of the sea from the technological wastes in the Bays of Vlora and Drin, in the outfall of Seman, Shkumbin, Mat, etc. ; ruinous explotation of the sand masses of the rivers and coasts ; the consequences from the forced reclamation of the wetlands; the illegal use of explosive materials for fishing that have caused reduction of valuable fish and of *Penaeus kerathurus* catches.

8. There is a great interest on littoral lagoons for their biological, ecological and economical importance. Their general surface is 15 000 ha. They are not only important centers for the fishery (about 8 000 kv/year), and producing of the salt (Narte, 120 000 tons/year), but also they are important centers of the water-fowls (*Ardeidae, Phalacrocoracidae, Pelecanidae, etc.*). The lagoon of the Karavasta is wellknown for the nesting of *Pelecanus crispus*. Near the lagoons there are some natural parks and reserves (GJIKNURI *et al* ., 1991).

9. It is forecasted that the albanian coast will be in the near future an object of a broad intervention, especially for tourism. It is forecasted that only in 1996, the tourism will be extended with 35 000 beds (from 4 000 of nowadays), whereas up to the year 2 000 this number will reach 100 000. There have begun, a year ago, the prospects for the gas and oil by five foreign companies in the shelf of the albanian coast. Their activity can not exclude the potential danger for the pollution of the environment.

The definition of the values of the different zones of this coast, their classification according to the priorities, and on this base, the planification of the protection and exploiting masses from all points of view, are some of the problems that need quick solutions. Some international organisations have offered their help for the studies of the Albanian coast.

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Remote sensing of dynamic patterns in the Adriatic Sea

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The intention of the present work is not to review the overall remote sensing contribution to our understanding of the physical oceanography of the Adriatic Sea in the last decade. While remote sensing technology enables detection of the sea surface temperature, colour, roughness and distance from the sensor, we limit our attention here to colour/derived pigment (Coastal Zone Colour Scanner - CZCS) and temperature (CZCS infrared channel and Advanced Very High Resolution Radiometer - AVHRR). Majority of remote-sensing related publications on the Adriatic justifies such a choice. Furthermore, we make distinction among works dealing with *in situ* calibration of pigment and temperature derivation algorithms, those dealing with direct interpretation of pigment and/or temperature fields, and finally investigations that make use of pigment or temperature data to corroborate *in situ* measurement and/or mathematical modelling results or to derive current field information. We pay particular attention to the last group and focus on remote sensing contribution to currents and circulation studies of the Adriatic.

To this end we have first briefly reviewed a decade of classical oceanographic work (data analysis and mathematical modelling) following ORLIC *et al.*, (1992). The review demonstrates researchers' bias towards general-circulation and wind-induced current related themes, over the subjects of tidal currents, inertia-period oscillations and eddies. A similar review of remote sensing papers shows predominant use of pigment and temperature fields to corroborate empirical and/or modelling findings regarding surface dynamics (often general-circulation related features), and a somewhat surprising lack of interest in pigment or temperature fields *per se*. However, it must be remembered that direct use of pigment and temperature requires reliable derivation of those fields from noisy remotely detected scenes. Consequently, the need for, and interest, in pigment fields seems to be reflected in a number of papers that have been devoted to retrieving algorithms calibration.

Within the framework of auxiliary use of pigment and temperature data we consider in more detail studies that relate remotely observed patterns to the influence of the Po river discharge. BARALE *et al.* (1984) were among the first to use the CZCS visible radiation and apparent temperature to trace motions in the surface layer. Most recently STURM et al. (1992) explored Po-affected pigment patterns on the Adriatic shelf. The two works span a series of papers that consider the extent to which remotely observed patterns correspond to a particular, more conventionally studied, aspect of the Adriatic Sea circulation.

In conclusion we project the most immediate future for the remote sensing research of the Adriatic Sea.

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Gelatinous aggregates in the northern Adriatic : Water column processes

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In the waters of the shallow Northern Adriatic, algal blooms and discoloured waters are not exceptional since it has an enhanced terrigeneous input of organic and inorganic nutrients, and essential metals. During the summers of 1988 and 1989, sticky whitish yellow slime accumulations, up to 15 centimeters thick and several kilometers long, concentrated along the western and to a lesser extent eastern coasts of the Northern Adriatic. The phenomenon was repeated during August 1991.

The first public report of similar gelatinous (mucus or slime) accumulations in the Northern Adriatic dates back to 1729 and detailed descriptions exist for the outbreaks in 1872, 1891, and several others in the 20th century. Marine scientists have long been puzzled by this phenomenon and it is still poorly understood. Microscopic examination of the collected material showed that generally the mucus contained different planktonic and sometimes benthic organisms. Various species of pelagic diatoms, from time to time dinoflagellates and benthic diatoms, were most frequently recorded, as well as numerous cyanobacteria.

In view of the dominant organisms found within the mucus, some authors suggest that mucus is produced by phytoplankton, though others cast doubt on its pelagic origin, implying that it is derived from benthos. Data and field observations of mucus structure, behaviour and the organisms involved have accumulated, and several authors tried to explain the mechanism of the phenomenon by analysing the biochemical composition of mucus, surveying aggregates for organisms, and determining environmental factors before and during the outbreaks, but none convincingly.

In 1990, a research programme aiming at elucidating the origin, development, and consequences of gelatinous aggregates in the Northern Adriatic was launched by the Observatory of the Northern Adriatic, Trieste, with participation of five laboratories from Austria, Croatia, Italy (regions Friuli-Venezia Giulia and Veneto) and Slovenia. A field programme in the Northern Adriatic including the Gulf of Trieste and the Kvarner region followed the development of water column stratification, inorganic and organic nutrient dynamics, seasonal changes in suspended matter, microbial plankton, phytoplankton, microzooplankton and net zooplankton, sedimentation rates, microphytobenthos, meiobenthos and macrobenthos. The *in situ* distribution, development and transformations of macroaggregates were surveyed by SCUBA divers and different types of aggregates analyzed biochemically and under the microscope.

Of the two years studied, the summer of 1990 was characterized by modest development of macroaggregates in the form of stringers up to a few centimeters long, little flakes and loose masses in the form of small clouds or veils, but without larger accumulations on the surface. The distribution of macroaggregates within the water column was related to the stratification. During 1991, besides the forms observed in 1990, larger and more compact rounded structures were observed in the water column in July, and initially transparent strands on the surface amassed into sticky slime accumulations along the northern Adriatic coasts during August.

In this communication a preliminary analysis of some data deriving from the northern Adriatic Observatory Programme is given, and the importance of different pelagic processes for macroaggregate development and slime accumulations is discussed.

Marine snow, mucus aggregates and bottom anoxias: Consequences for benthic-pelagic coupling

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In the years 1988 and 1989 floating carpets of gelatinous substances ("mucilagine") covering great parts of the Northern Adriatic shocked fishermen, tourists, politicians and scientists alike. At least the latter had known large mucus aggregates as an episodic feature of the summer water column for many years and fishermen's tales of nets clogged by gelatinous masses ("mare sporco") are known from several places for the last century.

Several conflicting hypotheses have been put forward for the observed phenomena and a collaborative research project in the framework of the ARGE Alpen Adria has been implemented involving research groups from Italy, Croatia, Slovenia and Austria. We want to review here the state of knowledge of the effect of this phenomenon on the benthos and on exchange processes between the sea bottom and the water column.

Towards the end of spring phytoplankton blooms small flakes appear derived from extracellular released organic matter by phytoplankton algae. In a well mixed water column these flakes settle to the bottom and are consumed and remineralized by benthic biota. When the end of the spring bloom and the production of the initial flakes extend into the stratified period typical of the North Adriatic summer, the flakes are prevented to settle through the pycnocline into the cold and dense bottom water and remain in the superficial water column. Colliding flakes may merge into larger aggregates, forming "stringers" and "clouds" constituting spatial heterogeneities within the water column, showing enrichment factors for nutrients, phytoplankton, bacteria and flagellates of several orders of magnitude whereas the ambient water appears to be depleted in nutrients and biota. Larger aggregates efficiently trap inorganic (e.g.clay) or organic particles (such as fecal pellets) on their way to the bottom and prevent their sedimentation, effectively closing off the bottom from the input of organic matter. Towards the end of the summer the "clouds" - having attained a size exceeding 1 m - collect at the pycnocline in depths between 15 and 20 m. They are laden with trapped particulate organic and inorganic matter, their interior is anoxic with high concentrations of hydrogen sulfide. Within a few days they settle through the pycnocline and arrive on the bottom of this shallow sea.

Settling clouds suffocate filter feeding epibenthic fauna, such as sponges and ascidians. The ensuing hypoxic or even anoxic conditions, due to the oxygen consumption during the breakdown of this pulse of organic matter in the confined bottom water layers, leads to mass mortalities of the macrobenthos over hundreds and even thousands of square kilometers within a few days. The consequence of the formation of the mucus aggregates thus becomes the cause of bottom anoxias. The regeneration of these bottom communities consisting of large perennial species takes many years and has not been completed in many locations affected within the last decade due to recurrent oxygen crises, thus depriving the system of a possible regulatory mechanism for pelagic biomass production through the grazing action of the benthic suspension feeders. In this way the consequences of bottom anoxias may contribute to the causes of further blooms and mucus aggregate formation in a vicious circle.

Although Marine Snow is an ubiquitous phenomenon in all seas, mucus aggregates of the size and extent as those described above have rarely been described outside the Northern Adriatic. Its origin lies in the pelagic system. Microphytobenthos production - which has been suspected as the cause of the "mare sporco" cannot account for the observed large scale phenomena due to its small magnitude. The generation of extensive subpycnocline anoxias - which is also typical for other areas experiencing similar water column conditions (Skagerak, Gulf of Mexico, Chesapeake Bay) - interrupts the usual pathways coupling the pelagic and benthic systems. The previously existing regulatory feedback between pelagic production and benthic consumption by large sized suspension feeders is replaced by a one-way forcing of the benthic biota by escalating pelagic processes.

The Adriatic Sea in the prospect of integrated coastal area management

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The Adriatic Sea is considered in relation to the prospect of implementing coastal area management, namely of increasing rationality in sea resource uses and protecting the ecosystem. The main objectives of this paper are to : (i) put into evidence a range of leading factors and processes through which the management of the Adriatic Sea differs from that of other parts of the Mediterranean Sea and, *sensu lato,* of the semi-enclosed marine basins as a whole; (ii) to approach these aspects and processes through some general system-based conceptual tools; (iii) to relate the subsequent deductions to the directions that the United Nations system has provided for implementing coastal area management.

Analysis starts from some natural processes relating to plate tectonic dynamics and climatic, hydrological and erosion cycles, and deals with: (i) the establishment of the jurisdictional continental shelves which has opened the prospect of setting up coastal management patterns; (ii) the nature and content of the potential Adriatic management pattern; (iii) the Adriatic use framework; (iv) the Adriatic **use-use relationship model** leading to the consideration of **coastal use differentiation-coordination optimum;** (v) the Adriatic **uses-coastal ecosystem relationship model** relating to the need to prevent collapses of the ecosystem.

Through this approach the complexity of coastal management is self-evident. On the one hand, the Adriatic sea is subjected to natural processes making the ecosystem fragile. On the other hand, this semi-enclosed sea, included in a wider semi-enclosed sea, namely the Mediterranean Sea, is affected by high human pressure in the Italian side and is involved in a wide range of resource uses which to a large extent are conflicting. Because of this, advanced methodologies are to be experienced in order to ensure evolutions in management consistent with the need to enhance the environment and keep available sea resources for future generations.

The conclusion is that these methodological bases are consistent with the leading principle of the Integrated Coastal Area Management (ICAM) but that, in spite of the efforts made by the United Nations system, the route to the establishment of specific methodological approaches is still to be delineated. In this context the Adriatic Sea can be regarded as a marine area to which experimental and driving ICAM-inspired initiatives are appropriate.

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Large-scale oceanic features detected by airbone and spaceborne SAR in the Mediterranean Sea

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Airborne SAR DATA

During the MAC-Europe Campaign in June/July 1991, the NASA JPL synthetic aperture radar (SAR) carrying a polarimetric 3-frequency SAR operating at 440 MHz (P-Band), 1.25 GHz (L-Band) and 5.30 GHz (C-Band) flew several missions over the Gulf of Genoa and the Strait of Messina.

On 22 June 1991, SAR images were taken over the Gulf of Genoa showing an anti-cyclonic eddy south of Genoa with a diameter of approximately 15 km. Model calculations carried out by V. CASULLI (University of Trento) and G. MANSELLA (ENEA, La Spezia) show that this eddy is generated by the modification of the steady cyclonic circulation caused by wind forcing and the interaction with the coastline and the bathymetry. This model result is also substantiated by AVHRR images.

On 28 June 1991, SAR images were taken over the Strait of Messina showing a strong non-linear internal wave train south of the Strait of Messina. This wave train was imaged several times. By correlating successive SAR images, the propagation speed of the internal waves was determined.

During the passes over the Strait of Messina the JPL SAR was operated in an interferometric SAR-mode by using two antennas. Surface current velocities as well as correlation times are derived from these interferometric data (R. CARANDE, JPL)

Spaceborne (ERS-1) SAR Data

ERS-1 SAR images were obtained on several occasions in the period from 7 January to 22 March 1992, over the Strait of Gibraltar during spring tides. These images show non-linear internal wave patterns propagating eastward as well as long wavelength patterns in the western part of the strait which are very likely caused by atmospheric effects.

On May 17, 1992, an ERS-1 SAR image was obtained over the Strait of Messina during a spring tide. This image shows internal waves north of the Strait of Messina.

The ERS-1 SAR images obtained over these two Straits are interpreted oceanographically.

Advances in the detection of oil pollution by remote sensing

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Mineral oil spills appear on the ocean surface radar images as dark patches. However, dark patches can also be caused by natural surface films floating on the sea surface. These natural surface films are produced by plankton or fish and are often encountered in coastal regions where the biological productivity is high.

Monomolecular surface films reduce the radar backscattering cross section by a similar amount as do mineral oil films. This implies that the exclusive application of a single-frequency radar for monitoring oil pollution would often lead to false alarms.

However, there seems to exist a possibility to discriminate between mineral oil films and monomolecular sea slicks by using multi-frequency radars. This technique exploits the fact that the damping of ocean surface waves exhibits a resonance-type behaviour in the short gravity wave region which can be described by Marangoni wave damping theory (see e.g., CINI and LOMBARDINI, 1978).

Results of multifrequency radar backscattering measurements carried out over several artificial monomolecular sea slicks of different physico-chemical properties and over mineral oil spills in the North Sea are presented. They show that the functional dependence of the reduction in backscattered power on radar wavelength and incidence angle is quite different for monomolecular sea slicks and mineral oil films.

It is proposed to exploit this difference in developing a multifrequency radar technique by which it is possible to discriminate between mineral oil films and natural surface films.

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Ocean colour, planktonic pigments and productivity

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The general term *ocean colour* is used to indicate the visible spectrum of upwelling radiance as observed at the sea surface. This radiance is related - by the processes of absorption and scattering - to the presence, nature and abundance of substances in the surface layer of the sea, the *water constituents (i.e.* planktonic pigments, the concentration of which can be related to biomass in the first optical depth of the water column; degrading organic matter, such as the so-called yellow substance; or total dissolved and suspended matter in general). Different water masses can be classified according to the kind of the water constituents shaping their optical properties (see BARALE, 1991, and references therein).

Two main water types, referred to as *case 1* and *case 2* waters, can be identified in the sea. In *case 1* water, the optical properties are dominated by biological constituents. These include the photosynthetic pigments of phytoplankton, as well as other dissolved organic matter liberated by the algae and their debris. This water type is usually found offshore, but it occurs also in coastal regions with arid climate, considerable depth and limited coastal runoff. The range of *case 1* water spans from blue, oligotrophic waters (with pigment concentration below 0.1 mg/m^3), to biologically active waters (pigments concentration around 1 mg/m^3), as well as to green, eutrophic waters (pigment concentration as high as 10 mg/m^3) like those found in upwelling areas. *Case* 2 waters include as well particles from terrestrial runoff, suspended sediments of variable nature, dissolved organic matter and other particulate substances. This water type occurs in coastal zones with high coastal and fluvial runoff, or near mud flats, estuaries and river deltas, as well as in shallow offshore zones. The total area covered by *case* 2 waters, not optically dominated by plankton alone, is just a small fraction of the global marine surface. It represents however an important topic of research, as it is in such waters that most human activities take place, that most of the marine resources to be exploited concentrate, and that most dramatic can be the dangers connected with environmental pollution.

The retrieval of environmental parameters from ocean colour observations depends essentially on the understanding of in-water optical properties, and of non-marine *(i.e.* atmospheric) contributions to the remotely sensed signal. In practice, it is necessary to develop algorithms and/or models describing the relationship between remotely sensed radiance and water constituents. A considerable experience has been gained in this field by virtue of the Coastal Zone Color Scanner (CZCS) experiment (HOVIS *et al.*, 1980). Three main kinds of algorithms must be used to estimate marine environmental parameters from the signal measured from a sensor like the CZCS (GORDON and MOREL, 1983). First, the sensor-recorded digital counts are converted into apparent radiance values by means of a *calibration* algorithm, accounting also for sensor response variations. Second, the apparent radiance values are corrected to derive upwelling water radiances, or sub-surface reflectances, by means of an *atmospheric correction* algorithm. And, third, these estimates are used to calculate pigment concentration or, in alternative, other parameters such as total suspended matter, or a diffuse attenuation coefficient, by means of a *pigment* algorithm.

The remote assessment of optical properties of the sea surface finds several applications in the fields of marine biology and ecology at large, water quality and sediment transport, water circulation and dynamical processes, as well as in the fields of energy transfer, carbon cycling and climatology in general. In the Mediterranenan region, CZCS data have been used to explore processes related, one way or the other, to coastal and river regimes. The basin, in fact, presents relatively clear, oligotrophic waters in the pelagic region, where the signal due to planktonic pigments is low, but has dynamic near-coastal areas, where peculiar phenomena occur, and enclosed basins which model the larger oceans. Major rivers such as the Nile, Danube, Rhone, Po, Ebro, Guadalquivir have distinct plumes interacting with the marine dynamical and bio-geo-chemical environment. Within the range of the plumes - as in coastal areas in general - it is often impossible for the CZCS to distinguish the signature of biogenic pigments from that of other dissolved and suspended water constituents. However, the observation of such features provides important clues on frontal or current dynamics, and on potential correlations with nutrient enrichment or pollution.

Another promising application is that concerning primary production assessments, which involve the combined use of remote estimates of biomass and a suite of auxiliary data on plankton distribution, properties and physiological state. In order to evaluate the daily production of a given area of sea surface one also requires : estimates of the irradiance at the sea surface, corrected for cloud cover; at least two parameters of the photosynthesis *vs* light curve; and at least three parameters of the biomass profile *vs* depth. Early developments on this subject include empirical approaches to the correlation of pigments, biomass profiles and production, and spectral light/photosynthesis models. Applications have been reported for the Mediterranean Sea, and in particular for its western basin (MOREL and ANDRE, 1991).

At present the complete CZCS image archive on the sites of European interest is being exploited in the framework of the Ocean Colour European Archive Network (OCEAN) Project. This integrates three long-term objectives: to generate a European data base of bio-optical information on the marine environment (using the historical CZCS data); to promote the use of ocean colour data in an Application Demonstration Programme devoted to marine regions of European interest; and to develop a 'network' of scientific groups and facilities capable of supporting in Europe future ocean colour missions.

The main requirement for future ocean colour sensors is to reduce the number of unknowns when retrieving pigments from radiance spectra. At present, the factors which limit the use of ocean colour are the determination of the aerosol contribution to the signal, the separation of the contribution of different water constituents from that of planktonic origin, and the retrieval of information about the vertical distribution of the phytoplankton, its specific absorption, and its physiological state. Imaging spectrometers will improve the potential of ocean colour applications (see VAN DER PIEPEN *et al.*, 1991). However, increased investments will be required to solve residual problems in data pre-processing, archival, high-level data processing and scientific analysis, and coordination for research activities.

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Topographie océanique
Perspectives de TOPEX/POSEIDON

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La nécessité de connaître le rôle de l'océan dans l'évolution du climat a été soulignée. Connaître c'est observer, mesurer pour pouvoir modéliser. Les mesures effectuées doivent avoir une exactitude et un échantillonnage optimisé pour obtenir des réponses quantitatives. Le rôle unique des observations par satellite tient à leur précision, à la couverture dans l'espace et le temps, et à la technique de mesure utilisant un instrument unique soigneusement calibré.

Parmi ces techniques, l'altimétrie joue un rôle majeur. Instrument tout temps, le radar altimètre a une précision centimétrique. Si on fait avec soin grâce à des mesures auxiliaires les corrections dues au milieu de propagation (ionosphère, troposphère) et aux propriétés du milieu réfléchissant (biais électromagnétique) la mesure verticale satellite-océan est connue avec une précision de 2 à 3 centimètres. Pour l'interpréter il faut connaître l'orbite du satellite porteur avec une précision équivalente. On a alors accès aux variations de la topographie océanique.

La topographie moyenne en l'absence de courants, appelée géoide marin, est une équipotentielle du champ de gravité. Les "trous et bosses" sont la signature gravitationnelle des structures géophysiques terrestres : convection dans le manteau, évolution de la lithosphère océanique. L'interprétation permet de participer à la connaissance de la terre.

Superposé au géoide marin on trouve le signal venant de la circulation océanique : une composante moyenne et des variations temporelles. Les variations temporelles sont à toute échelle d'espace et de temps. On peut distinguer les grands courants de bord ouest, l'activité turbulente - découverte dans les années 60 - des anneaux et tourbillons, les ondes se propageant à travers les océans tropicaux, les variations saisonnières, annuelles et interannuelles liées aux variations de forçage par échange thermique ou friction du vent, les effets des marées luni-solaires, sans oublier les variations séculaires - variations du niveau de la mer - dues au réchauffement thermique direct et à la fonte partielle des glaciers tempérés et calottes polaires.

Pour mesurer de façon fiable ces différents effets et introduire les mesures par des techniques d'assimilation dans des modèles, il faut définir un système altimétrique prenant en compte le spectre des différents phénomènes. L'altimétrie par satellite a déjà donné grâce à GEOS 3 (75), SEASAT (78) et GEOSAT (86-89) des résultats importants qui seront rappelés. ERS-1 lancé en juillet 1991 est équipé d'un radar altimètre venant assurer le relais avec les missions précédentes. TOPEX/POSEIDON est une mission altimétrique de référence conçue comme telle, lancée en juillet 1992. Le satellite est placé sur une orbite soigneusement sélectionnée. La charge utile comprend 2 altimètres - dont 1 bifréquence - 3 systèmes de positionnement précis, 1 radiomètre radiofréquence, un système de contrôle d'attitude et de maintien d'orbite.

De plus le segment sol a été conçu de maniere à fournir des données géophysiques calibrées, et dont l'exactitude est vérifiée, à la communauté des océanographes et en tout premier lieu aux 38 chercheurs principaux du Sciences Team qui ont participé à la conception de la mission et à l'évaluation des premières données.

TOPEX/POSEIDON est le premier satellite scientifique conçu dans le cadre du programme WOCE (World Ocean Circulation Experiment) dont il est un des éléments majeurs. Le satellite ERS- 1 apportera un complément essentiel, l'altimétrie assurera la couverture des zones polaires et un complément d'échantillonnage. Le diffusiomètre donnera une connaissance du champ vent. WOCE recueille depuis 1991 et pour 5 ans au moins dans une première phase les données océanographiques. Il s'agit d'un effort international sans précédent: nombreuses sections hydrographiques, recueil d'échantillons d'eau de mer, mise en place de plusieurs centaines de bouées de surface, de flotteurs immergés, déploiement de courantomètres, de marégraphes, de systèmes de sondages acoustiques. Les modèles dont le développement est facilité par la capacité des grands ordinateurs assimilent ensemble les données spatiales assurant la couverture mais limitées à la surface et les données in situ.

Dans 5 ans nous disposerons d'un modèle de base réaliste de la circulation océanique incluant un modèle complet de marées, des valeurs des échanges thermiques entre océans et notamment leurs variations saisonnières, annuelles et interannuelles. Ces modèles d'océan seront couplés avec des modèles d'atmosphère et permettront la prévision du déclenchement et de la relaxation de phénomènes planétaires tels El Nino. La quantité de carbone absorbée pourra être calculée. Une limite supérieure des variations du niveau de la mer pourra être donnée.

Ce premier effort doit être suivi par une observation permanente du système océan pour plusieurs décennies. Les délais pour décider et mettre en oeuvre des systèmes spatiaux nécessitent des décisions rapides. L'expérience acquise par TOPEX/POSEIDON et ERS-I permet d'ores et déjà de fournir tous les éléments techniques et scientifiques.

The role of Semi enclosed seas role in the new Space observation era

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The Mediterranean is taken as the most representative and complex case of the major semi-enclosed seas of the world. In the face of global environmental and climatic changes and of demographic explosion, satellite monitoring appears as an essential premise for its integrated management.

A timely assessment and prediction of the impacts of such changes depends on the availability and proper processing of interdisciplinary data, on scientific understanding of reliable information and on subsequent continuous monitoring for control.

Data - the major source of analysis and modelling - are still failing to satisfy users in time, space, quality and quantity; they need better integrated collections, overall standardisation, intercomparability and long continous time series of *in situ* measurements. The new generation of Earth observation satellites planned by ESA, NASA and NASDA will provide a major contribution to the solution of these requirements but the exponential increase of the amount of data will require sound management including validation, distribution and technology of use. The planning of such management is in progress, or proposed by various international and national organisations at the present time.

An integrated management of ground and space data aimed at scientific and application users is needed also in the Mediterranean region. Archives of monitored data are planned in programs such as MEDIAS, an IGBP proposed regional center, or in long-term experiments and research programs such as PRIMO, POEM, or the Blue Plan. They should not exclude larger views of interdisciplinary data sets and the creation of meta-data referral systems with a coordination of UNEP, EEC, CIESM, WMO and other international and national organisations that deal with the many contributing factors of environment variabilities and trends. This would further serve such actions as planned by the World Bank and the European Development Bank in the Mediterranean area.

The Mediterranean has unique features. Placed between temperate and subtropical regions, from mountains to deserts subject to large seasonal variabilities, it is a challenging area for science. Oceanographers have always considered it a convenient model sea where most ocean mechanisms occur at time scales often one order of magnitude smaller than on the main oceans, and where campaigns can be conducted with less strain.

In order to better define the role of this semi enclosed sea on the global scale climate and environment change, and in reverse its response to global scale changes, research should be directed with greater priority towards the understanding of regional and global scale processes relationship. Compared to the global oceans, the relatively small semi enclosed seas offer the best opportunity to study and understand integrated mechanisms and relate them later to the global scale ones, as they offer excellent test areas for experiments, calibrations, interdisciplinary research and synergisms.

A number of interesting questions find answers in this regional context, for example the possibility to plan interdisciplinary research between meteorologist-oceanographers and hydrologists, so as to deal with the problems of water, from precipitation trends, catchments, runoff and ocean mixing and evaporation and coastal alterations. This could be a subject of discussion within CIESM and with other international organisations. There is also an opportunity, in this decade, to frame local and regional research in the major global international research programs such as WCRP, WOCE, TOGA, GEWEX, IGBP.

One other major contribution to environmental and climatic changes would be to transform the bibliographical wealth of CIESM in a practical information and referral system for the study of historical evolutions, variabilities, and tendencies. The present and coming earth observation management may benefit from historical data when alterations of specific processes and trends must be verified in a relatively short time. With a quality screening of products performed yearly by CIESM Committee chairmen and periodically by the Director in an integrated review of interdisciplinary mediterranean evolution there is certainly a way to derive useful syntheses and overall information on mediterranean facts.

The major Space Agencies including ESA are oriented towards new strategies in the organisation of the Space and Ground components, separating routinely Earth Observing services from Environment monitoring and scientific research. To prepare professionally each nation and user to benefit from this gigantic Earth Observing system will take time. But time should not be lost if we want to keep pace with the technological advances and facilities offered. Perhaps CIESM can contribute to enhance the know-how and progress in the role of science for a better life.

Remotely-sensed sea surface temperatures : cheap, adequate, convenient and significant information for all disciplines

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The physical oceanographers who have been processing infrared satellite data for about 20 years integrate more and more the resulting information to put forward working hypotheses, prepare and conduct experiments at sea and analyse *in situ* measurements. This should account for the interest to be given to a signal emitted by a few-micron superficial layer.

Nevertheless, some field physicists remain unattracted by this information as well as many biologists, chemists, sedimentologists and other scientists working on marine pollutants or coastal engineering. A major reason might be that the importance of the mesoscale phenomena (10 to 100 km, days to months), which are relatively intense and have generally a strong signature on the sea surface temperature (SST), is often underestimated. The aim of this presentation is to bring more evidence about the interest every scientist should find in analysing remotely-sensed SST images.

Practically, while in the office, one can purchase (sometimes with less than a dozen ecus a 1000km x 2000km scene with a $\approx$1 km2 pixel) either numerical data or printed images at several places where these data have been archived for years. While at sea one can receive data in real time on board. It is possible to process the data and get coloured SST images with a simple micro computer in few tens of minutes. Provided the signal is oceanographically relevant, which is easily checked with basic knowledge and a bit of practice, one can infer information on the distribution of the surface water masses, the direction of the surface currents and, with a minimum background in physical oceanography, have indications on the dynamical structure at depth. Several examples will be given about the relationships between SST and parameters relevant to disciplines other than physical oceanography.

An atlas covering the whole Mediterranean Sea, and dealing with the analysis of representative images, monthly maps of thermal fronts and statistics collected during a 9-year period (LE VOURCH *et al.*, 1992) will be presented and made available during the congress.

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A

Télédétection et gestion du milieu côtier

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A

La télédétection, si on l'entend au sens "télédétection satellitaire", peut apporter aux gestionnaires des systèmes côtiers des éléments d'analyse utiles pour répondre à un certain nombre de problèmes. Elle peut être associée de façon complémentaire à la photographie aérienne. Des exemples pris en Atlantique me permettent de soutenir mon propos et de montrer quelques-uns des domaines où ce moyen d'acquisition des données se révèle très efficace.

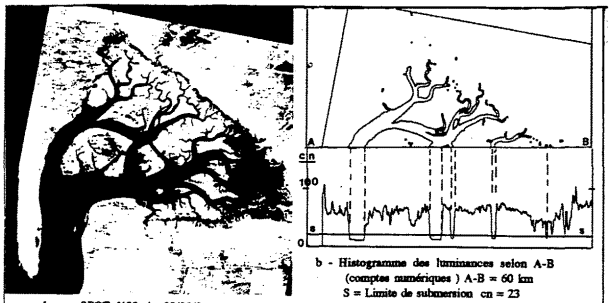
I. Connaissance et tracé de la ligne de rivage instantanée

La vitesse d'atténuation de la lumière dans l'eau est fonction de plusieurs paramètres principaux : la longueur d'onde du rayonnement, l'épaisseur de la tranche d'eau traversée, la pureté des eaux et leur charge en particules, la présence ou non d'un fond homogène.

Le rayonnement est absorbé plus ou moins vite en fonction de la longueur d'onde. En particulier, le Proche Infra-Rouge (SPOT XS3, 800-900 nm) est soumis à une absorption très rapide et quasi totale en quelques centimètres d'eau C'est une propriété intéressante pour définir sur les images la limite continent-eau. Des études expérimentales en cuve ont évidemment confirmé ce processus et montré que 50% de l'énergie lumineuse du Proche Infra-Rouge disparaissait dans les 8 premiers centimètres d'eau claire, et qu'à partir de 15 cm, on pouvait considérer que l'absorption était presque totale.

- application

L'exemple de la lagune d'Arcachon (côte atlantique de la France) est démonstratif.



b - Histogramme des luminances selon A-B (comptes numériques) A-B = 60 km
S = Limite de submersion cn = 23

a - Image SPOT XS3 du 08/09/91
© CNES-SPOT IMAGE

Les images SPOT XS3, Proche Infra-Rouge (fig a), sont utilisées et une étude des histogrammes des comptes numériques des images effectuée sur des transects de la lagune (fig b). Une "limite de submersion" qui correspond au passage eau-plage a donc été définie et vérifiée sur le terrain. Le tracé sur les images XS3 de la courbe isovale correspondant à cette valeur coïncide avec la ligne instantanée de côte. Sa précision cartographique est celle du pixel, en surface, 20m, et, en profondeur, on peut estimer l'erreur comme inférieure à 15 cm. Cette marge d'erreur est tolérable pour une cartographie à 1/20.000.

- extension à la cartographie de la zone intertidale

Dans le cas d'une mer à marée, il est tentant de rechercher les images prises à différents moments de la remontée du niveau marin et de tracer ainsi plusieurs lignes de côte instantanées. Ceci a été fait pour la lagune d'Arcachon dont la cartographie des milieux intertidaux a été obtenue avec cinq images correspondant à cinq situations différentes de 1,2 à 3,5 m au-dessus du niveau des plus basses mers.

II. Connaissance de la bathymétrie

Si la longueur d'onde du Proche infra-Rouge est rapidement absorbée, en quelques centimètres d'eau, les longueurs d'ondes du vert et du jaune-rouge sont susceptibles d'une pénétration importante dans le milieu marin, et donc de révéler les formes sédimentaires qui le tapissent et de permettre une approche cartographique sur de faibles profondeurs. Les études ont montré que la pénétration maximale se situe en zone côtière vers une longueur d'onde de 550 nm, soit au centre de la bande XS1 de SPOT. La bande XS2, centrée sur 650 nm donne quant à elle des informations sur des profondeurs moindres. Dans le cas traité ici, celui des passes d'entrée de la lagune d'Arcachon, nos estimations se sont limitées à 10 m. La procédure a été de rechercher des documents de validation sur le terrain, en l'occurence une carte récente à grande échelle, d'associer aux valeurs de la bathymétrie les valeurs radiométriques de l'image, de définir enfin une courbe d'ajustement entre ces deux séries de valeurs, et d'utiliser cette corrélation pour associer aux courbes d'isoluminescence de l'image une valeur de bathymétrie.

La spatiocarte obtenue, comparée à la carte bathymétrique montre cependant des déplacements de bancs de sable, des nouvelles formations qui sont intervenues dans un délai court de quelques semaines. Ce moyen d'obtenir un instantané de la topographie proche de la surface ne peut cependant être reproduit sans précautions à d'autres moments, il convient alors pour la comparaison des cartes de tenir le plus grand compte des variations de visée, de hauteur du soleil en particulier.

III. Suivi en mer des matières en suspension expulsées par les fleuves

Les matières en suspension expulsées par les fleuves ont un effet très important sur les environnements côtiers et océaniques ; elles peuvent également servir de support à des polluants, et la connaissance de leur dynamique et de leur cinématique de dispersion peut s'avérer essentielle. SPOT XS peut être utilisé pour des cibles réduites en dimensions et NOAA (AVHRR) pour des surfaces plus importantes.

Les bandes XS1 et XS2 de SPOT conviennent pour une étude détaillée des fronts turbides, mais il est nécéssaire d'avoir une "vérité terrain", contemporaine de la date de saisie de l'image, sous forme de mesures de reflectances *in situ*, sur la surface de l'eau, et sous forme de prélèvements d'eau de surface pour des mesures de concentration de matières. Ces données, plus aisées à obtenir avec AVHRR (NOAA), permettent d'établir une courbe de corrélation entre radiométrie et concentration et, par la suite, de tracer les courbes isovales de concentration des sédiments en suspension en surface (exemple de la Gironde)

Major modifications of the Black Sea benthic and planktonic biota in the last decades

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Increasing eutrophication as well as other man-made activities have considerably changed the structure and functionning of the Black Sea ecosystems, mainly in its NW corner, affecting both the qualitative and the quantitative state of the benthic and planktonic phyto- and zoo-communities.

We attribute this change to the more rapid acceleration of changing interrelationships between anthropogenic influence and biota in this nearly enclosed basin during the last three decades.

The marked decline of the ecological health has induced marked changes especially in the structure of littoral ecosystems.

The **macrophytobenthos** has shown a gradual, but continuous, decline approximately since 1945-1950 due to both natural (e.g. occasional massive frosts) and anthropogenic factors (silting of the rocky bottom, increased turbidity, diminution of light penetration).

The previously large belts of *Cystoseira barbata*, a perennial brown alga, along the western coast have practically disappeared as have numerous other associated and/or epiphytic algal and animal species.

The present algal flora, which displays a reduced species diversity, is uniform. Generally it is dominated by *Enteromorpha intestinalis, E. linza, Ceramium elegans and C. arborescens*. These newly dominant species with short and nearly seasonal life cycles show considerable production but, nevertheless, they do not reach the levels attained by *Cystoseira* during previous decades.

The evolution of **zoobenthos** communities is marked by a qualitative impoverishment, expressed by the reduction of species number by 50-60% at the present in comparison with the 1960 period, as well as by the numerical reduction of numerous species which formerly were omnipresent in the communities.

The qualitative structure of the communities was altered by the diminution of those species which were prevailing and characteristic formerly (*Spio filicornis, Corbula mediterranea, Syndesmia fragilis, Spirula subtruncata, Mytilus galloprovincialis*) and by the proliferation and autoacclimation of some opportunistic species (*Neanthes succinea, Polydora limicola, Mellina palmata, Mya arenaria, Scapharca inaequivalvis*).

Increases in populations of opportunistic species did not compensate for the reduction of general biomass and density, which are lower by 35-84 % than those measured 25 years ago. The zoobenthic communities become more and more homogenous as a result of mass proliferation of a few species. Their community structure is unstable owing to permanent disturbance generated by blooms and related benthic mass mortalitites.

Following the more intense eutrophication, the biomass of the **phytoplankton** surpasses that of the past. Some essential structural changes have occurred and new quantitative and qualitative characteristics have been recorded.

The increase in the amplitude and frequency of algal blooms is a significant ecological consequence of the accumulation of nutrients in sea water. Since1970, blooms are no longer exceptional phenomena. For example, in the 1980's alone, 46 blooms due to 15 algal species were recorded in the Romanian littoral waters.

Besides the species producing the blooms, other numerous mass species are remarkably developped. During the 1980's, 79 species reached densities of more than 100,000 cells/l, as compared to 57 species in the 1970's and only 38 species in the 1960's.

From the 1960's up to the 1980's, the proportion of nondiatoms in the numerical density of the phytoplankton increased from below 8% of the total, up to 62% with a corresponding decrease of the diatoms. The changes of the quantitative proportions of the main algal groups are due to the changes in the nutritive basis. Theses changes include :

(1) the reduction of the ratios Si : N and Si : P (which is detrimental to diatoms), and (2) the increase of organic matter (which favors the phytoplankters with mixotrophic affinities belonging to Dinoflagellata, Euglenida, and Chrysophyta).

Between 1983 and 1990 the average biomass of phytoplankton in Romanian littoral waters was more than 8 times higher than that assessed between 1959 and 1963.

The evolution of the **zooplankton** communities was marked by simplification of structure and decline of the species diversity, especially in the shore areas. Besides the total disappearance of some species (three species of the copepods belonging to the family Pontellidae), the populations of some holoplanktonic species have diminished greatly, as for example *Centropages Kroyeri, Penelia avirostris, Evadne tergestina and E. spinifera.*

The population of the meroplanktonic component of the zooplankton (the planktonic larval stages of benthic biota) have also diminished as a consequence of the mortalities produced in the benthic fauna.

In contrast the density of a small number of opportunistic species (e.g. *Acartia clausi* and *Pleopis polyphenoides*) increased, the species becoming dominant in the communities.

Another characteristic feature is the explosive development of *Noctiluca scintillans*, especially during the summer, following a significant algal bloom (in the summer of 1986 and 1987, this species represented 91-99% of the entire zooplankton biomass). Massive accumulation of the jellyfish *Aurelia aurita* has also been recorded.

Between 1980 and 1987 the total zooplankton increased in mean values of density and biomass of up to 10 times as compared to the mean values in the decade 1960-1970, because of large populations of *Noctiluca* in the summer.

The trophic zooplankton has experienced a substantial decline of the population (especially during 1990-1991) and a decrease of the planktonophagous fish catches concomitently with the appearance in the Black Sea waters of *Mneniopsis leidyi* (a big consumer of plankton and fish juveniles). For the ecosystem components of the Black Sea as a whole, the inseparable relationship between the dynamics of community structure with space and time, as well as the variable character of dynamic processes at the community level, have become particularly obvious during the last thirty years.

Hydrology and water circulation in the Black Sea

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In the course of a century-long exploration of the Black Sea, oceanographers have managed to determine the major regularities of its hydrologic regime and water dynamics. However, until today we are faced with a host of questions of utmost importance, for which no coherent response has yet been provided. Amongst these is the problem of seasonally-varying water circulation, formation of the vertical structure, the active layer response to external forcing, primarily, to wind. Naturally, all these issues are related to the cardinal problem of water circulation in the basin.

It is well known that the Black Sea cyclonic circulation is composed of two basin scale gyros in the western and eastern parts of the deep central section. However, there exist a variety of contrary views of seasonal variability, position, configuration and intensity of these dynamic features. Summarizing the data from a series of studies, one may infer that the water circulation in the Black Sea becomes most intensive in winter and feeble in summer. On the other hand, analysis of the historical data on surface circulation of geostrophic lows in the upper Black Sea during late summer shows that in summer cyclonic circulation in the northwestern section of the basin frequently transforms into its opposite, when the recurrence of southerly and south-westerly winds increases.

All studies of the Black Sea current vertical structure point out that current velocities rapidly decrease with depth. Some investigators hold that an opposite-sign, that is anticyclonic circulation is likely at depths below 300 m, whereas other researchers adduce proofs to the effect that the water circulation in the deep section of the sea is one-layered. During the late autumn/winter period, the vertical current variability in the northwestern shelf area is relatively insignificant, with the exception of the thin near-bottom layer, being 1 to 2 m thick at most. in spring and summer, diverse dynamical situations are likely to occur, including an absolute disparity between the horizontal patterns of currents in the upper layer and the bottom one. Those phenomena, obviously, are the result of the water circulation's sign alternating in the area.

In the course of the 1980's, oceanographers were seeking to elaborate and validate the current views on the variable water circulation through the use of contemporary techniques of research, specifically, the monitoring of currents by moored buoys, numerical diagnostic computations of water circulation from density fields with the wind field and bottom relief taken account of, and the numerical calculations of circulation evolution under the impact of external forcing mechanisms (wind, heat and volume fluxes through the sea surface).

The investigations carried out in recent years have shown that alongside the quasi-stationary dynamic features and geostrophic water circulation in the Black Sea, there occur mesoscale nonstationary disturbances of planetary/wave character. The horizontal scales and the accessible potential energy of both modes of general circulation are comparable between them, which is consistent with the known theoretical concepts. Notwithstanding the seeming absurdity of the implication that mesoscale eddies and rim current meanders, travelling with the planetary (Rossby) wave velocity, are present in Black Sea climatic fields, physically, this conclusion appears to be more valid than the traditional views on the Black Sea pattern of currents.

In fact, a restricted size of the basin does not contribute to the formation of a baroclinic layer with thickness sufficient for the accumulation of accessible potential energy comparable with the oceanic one. This shows off in the relatively small intensity of the quasi-stationary elements of circulation, the latter's velocity being not larger than 10 to 11 cm. s-1. On the other hand, intense nonstationary external forcings, primarily, in the form of verticity induced by wind with a pronounced seasonal variability, with maxima occuring during transition seasons and minima during summer and mid-winter, cause the generation of planetary/wave mesoscale disturbances.

The relatively stable annual recurrence of specific atmospheric forcings adds to the likelihood of the repeatability of the Black Sea's typical nonstationary response, which is manifest even in the climatic (mean multi-annual) fields. The basin's being limited in size also facilitates the waters' regular dynamic response to the external forcing, since the related nonstationary motions are expected to have parameters of the confined basin's proper oscillations. Only such motions (both gravitational and planetary quasi-geostrophic) may have considerable energy for a sufficiently long time.

Analysis of the energetics of climatic nonstationary disturbances of water circulation has revealed that these occur mainly in the central deep-water part of the Black Sea. Here, the energetics of the process is largest. Its reduction in the coastal zone is equivalent, on the average, to 20 to 30 percent. Climatic disturbances are likely to generate less consistent synoptic fluctuations. Their energy is concentrated in the coastal zone. The principal mechanism behind these disturbances seems to be related to the Black Sea rim current's hydrodynamic instability. All these mesoscale motions in the open sea can give rise to the eddies and coastal trapped waves, alongside the local wind forcing.

The various types of mesoscale, nonstationary waves exist in the Black Sea and are permanently interacting. A result is the complex structure of water circulation retrieved from all quasi-synoptic surveys accomplished in various Black Sea areas. A goal of future research is to identify the different types of dynamic disturbances and to study their properties in detail. This will allow us to gain an insight into the major mechanisms responsible for the formation, transformation and variability of the thermohaline barrier. It should be anticipated that the entire Black Sea ecosystem is functioning in the same mesoscale nonstationary regime. Thus, a study of the latter may be of significant relevance in terms of various practical implications designed to improve management and control of the diverse activities in the Black Sea waters and its shores.

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Geophysical exploration of the Black Sea Region

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A study based on an extensive geophysical exploration conducted by Italy, the Soviet Union and Bulgaria has provided an important contribution to the reconstruction of the structures, stratigraphy and evolution of the Black Sea and surrounding area.

The Black Sea is formed by two basins separated by the Mid-Black Sea Ridge with a NW-SE trend. In the deep W-Black Sea basin the seismostratigraphic reconstruction indicates that, on a substantially flat acoustic basement attributable to a basaltic layer, a very thick (over 14 Km) sedimentary sequence lies. Sedimentary cover started in the upper part of Lower Cretaceous and continued until the present. In the E-Black Sea basin the acoustic basement is affected by tectonization and fault displacements and is covered by a sedimentary succession which began in the Middle Jurassic phase and continues until the present with a total thickness of about 13.5 Km.

The geodynamic reconstruction of the region is considered beginning from Middle Jurassic when the relative motion between Africa and Europa, and consequent North-ward subduction of Tethys, originated the back-arc basin of Great Caucasus where a complete crustal opening took place. In the same time the Black Sea area was stretched and sea channels and epicontinental sea were created. A successive more important distensive phase occured in the Lower Cretaceous when, according to a common scheme about the back-arc basins migration, the rifting moved Southward, producing Black Sea opening with formation of two basins the W-Black Sea basin evolued to the stage of complete crustal opening, the E-Black Sea basin to a stage of a very thin crust affected by numerous listric faults and block-tilting. This rifting process continued until the Paleocene.

From the Paleocene Black Sea margins were affected by different compressive phases that deformed and partially masked the distensive tectonic of the previous rifting phase. In Paleogene the N-ward movement of African mega-plate caused an anticlockwise rotation of the Black Sea crust producing a compressive phase the Great Caucasus region and the closure of the basin. In Middle Eocene time Shatsky Ridge was formed simultaneously to the Balkanides chain and the thick Kemchian foredeep.

The compressive movements continued later with development of the important alpine system of Crimea, Great Caucasus and Lesser Caucasus. The deformation, mainly South-verging, presents also important North-verging back-thrusts in front of which we can observe its Oligocene-Miocene (Maikopian for soviet Authors) foredeep named Indol-Kuban basin. The shortening is actually active with very evident thrusting process in the NE margin of the Black Sea and in the Lesser Caucasus where big earthquakes frequently occur.

Conservation des Ecosystèmes côtiers de la mer Noire

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Sur l'appui de l'expérience acquise en plus de 30 ans de recherche sur l'écologie de la mer Noire, l'auteur discute les principaux problèmes pratiques concernant la préservation de ce patrimoine naturel, dont la personnalité unique au monde est due, d'une part, à son caractère méromictique, et d'autre part à la grande productivité de ses écosystèmes côtiers.

Les modifications majeures enregistrées ces dernières décennies sont reflétées dans les structures écologiques à présent simplifiées, à évolution régressive, ainsi que dans la diminution générale de la productivité biologique utile, et dans l'appauvrissement des ressources génétiques et écologiques. Les modifications des processus écologiques sont, pour la plupart, des résultantes de l'intervention humaine directe ou indirecte sur la mer Noire, dominant massivement les perturbations et les changements naturels (croissance faible du niveau de la mer, transformations climatiques naturelles globales ou régionales, etc.).

Parmi les activités à action perturbatrice directe sont mentionnées : 1. le développement urbain, y compris industriel, des zones littorales ; 2. le développement de la navigation (construction de ports nouveaux, renforcement du trafic naval et liaison plus étroite de la mer Noire avec d'autres mers) ; 3. la pêche excessive de certaines espèces (les esturgeons aux embouchures du Danube, la chasse aux dauphins avec le fusil - un vrai massacre) et la pratique d'une pêche sauvage, antiécologique, par l'emploi du chalut de fond dans les zones littorales à faible profondeur ; 4. le renforcement des travaux hydrotechniques pour la construction de nouveaux ports, canaux, pour la protection des côtes et le maintien de la profondeur de navigation, etc. ; 5. l'augmentation des quantités d'eaux usées déchargées directement en mer (des plates-formes industrielles, des navires, surtout des résidus de produits pétroliers et de provenance domestique) ; 6. l'extraction pétrolière en mer (pour le moment, une action "propre", mais qui implique un grand risque écologique). L'impact indirect de l'homme sur les écosystèmes de la mer Noire est encore plus fort que son impact direct et se réalise par l'intermédiaire des fleuves tributaires (dans ce sens, la partie nord-ouest de la mer est la plus affectée car ici confluent le Danube, le Dniestr et le Dniepr, qui apportent 85% de l'influx d'eau douce du bassin entier).

Ayant en vue la situation écologique, en général précaire, des écosystèmes, et tenant compte de toutes les activités directes et indirectes qui peuvent maintenir et même empirer la situation, l'auteur présente des voies et mesures à suivre et à entreprendre en vue d'une préservation et valorisation durables, parmi lesquelles :

1. Prévention et limitation de l'impact des activités humaines sur les écosystèmes marins côtiers par : le renoncement en totalité ou la réduction des activités perturbatrices, le respect des standards et des normes de fonctionnement "propre", l'obligation d'instituer des études d'impact et de risque écologique pour les nouvelles capacités productives interférant avec le milieu marin côtier.
2. Meilleures connaissances et compréhension des processus écosystémiques et de leurs liaisons par le développement de recherches applicatives et l'observation permanente de l'évolution des écosystèmes dans le cadre d'un programme intégré de surveillance écologique, qui doit inclure aussi l'élaboration des prévisions à moyen et court termes.
3. Identification et évaluation des modèles optimaux d'utilisation des ressources et du milieu marin par le développement des recherches applicatives avec la réalisation de technologies nouvelles, non-polluantes et non-stressantes de manière directe ou indirecte, des écosystèmes côtiers.
4. Amélioration de l'état des écosystèmes côtiers par travaux et actions de reconstruction écologique (augmentation de la capacité de biofiltration et bioaccumulation dans les zones côtières par la construction de récifs artificiels et rideaux filtrateurs).
5. Création de programmes éducatifs incluant les problèmes de bio-éthique marine, qui soutiennent la conception selon laquelle la mer ne doit plus être considérée comme un récepteur illimité des déchets résultant de l'activité humaine.
6. Développement de la coopération internationale, par des actions communes comprenant la surveillance, la recherche et la prévision de la structure et du fonctionnement des écosystèmes, l'échange d'informations , l'adoption de décisions et réglementation, la standardisation des méthodes, etc.

A présent, le succès de la conservation et de la valorisation durable des écosystèmes côtiers dépend en grande mesure de la manière systémique et holistique d'approche des problèmes.

Technologies of coastal restoration in Eastern Black Sea

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The eastern part of the Black Sea coast mainly belonging to Georgia (313 km) is accumulative (62.3%) and abrasional-accumulative (37.7%). It is bordered by the pebble-sandy (80%) and sandy (20%) beaches.

Until 1982 the strategy of coast protection was the elaboration and building of new coastal protective structures. As long as this strategy deals with the results rather than with the reasons of coastal erosion it can not be considered as nature preserving. Thus total length of eroding coast in Georgia in 1961 was 155 km, in 1971-183 km and in 1981- 220 km. At the same time the total expenses of coast protection in towns (46km) and along the railways (18 km) were equal to 45 million roubles during 1961-1971 and to more than 80 millions during 1972-1981.

The Georgian Association of Seacoast Protection created in 1981 was in fact an experiment in the field of coastal management. Its activities are directed by the scientific-research institute of coastal morphodynamics. The latter integrates the scientific research, analysis, generalization of empirical data, experimenting and also plans their realization in space and time. According to its profile (study of seacoast nature) this institute developed qualitatively a new strategy of transforming seashore landscapes. The main goal of this strategy instead of protecting some sections of coast (e.g. with constructions or artificial beach nourishment) - is to achieve and retain the balanced budget of beachforming sediment in each dynamic system. In that case the whole energy of water is spent only in the transportation of sediment.

So the power of waves becomes creative instead of destructive. The weakened or intersected (by various reasons) interactions of adjacent sectors of shore are restored and the processes of self regulation of mobile beach zones along the whole morpho- and lithodynamic system are gradually reanimated. This is achieved by the different methods depending on natural conditions. At the same time constructing is considered as "surgery" and is applied only in exceptionel cases -when it allows to speed up the achievement of the above mentioned goal.

As a result of realizing this strategy the length of eroding coast in 1982-1991 was cut down to 80 km., 93.2 million roubles were spent at 110 hectares of beaches restored. Natural landscapes were created in place of concrete constructions which is quite important in towns and resorts too. It is worth mentioning that in cases like the Georgian seacoast - with steep pebble beaches, large sediment flow's length (tens of kilometers with capacities more than 100 thousand m^3 and velocities up to 200 cm/day etc.), numerous submarine canyons and so on even the artificial beach nourishment was considered inexpedient, nothing to say of the regulation of beachforming processes.

The new strategy is based on the results of investigation of sediment distribution during the evolution of coastal relief in the last 5-6 thousand years (i.e. in the period of slowing down and stabilization of transgression of ocean). It enabled us to work out the conception of discontinuous lithodynamic systems evolving almost autonomously and hence subject to regulation.

Impact of man on Black Sea ecosystem

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Acting as depository for anthropogenic wastes, the semi-enclosed seas of the World Ocean are subjected to man's greatest impact, particularly in highly industrialized coastal areas. Most of the pollution accumulates there, bringing about dramatical transformations in ecosystems, as evidenced by a variety of available data on ecological conditions. This paper compares the impact of man on the Black Sea ecosystem with that on the Mediterranean, Baltic and Azov Seas.

Based on the analysis of geomorphological, hydrological and hydrochemical indices of ecological capacity we conclude that the Black Sea is specifically susceptible to impacts. Very low rate of water exchange, nutrient- and H2S-contaminated water masses amounting to 90 % of the total sea volume, huge drainage area and dominance of river run-off over precipitation account for this phenomenon.

The comparative analysis between the four seas involved nutrient loading, pollution by persistent organic substances, heavy metals and oil. Obtained results were the gravest for the Black Sea. Since available data on microbiological contamination in the coastal waters of the Black Sea are scarce, further studies should be conducted.

The most pronounced transformations were found in the Black and Azov Seas ; they have been caused by anthropogenic pollution and suddenly reduced river run-off. The transformations include replacements in dominant and subdominant species, reduced number of species in all trophic groups, reduced average life in most populations, anomalous density outbreaks in several species including invasive species .

These changes were observed in all communities. The phytoplankton and phytobenthic communities were the first to undergo transformations as a result of high nutrient loading. The zooplankton and zoobenthic communities were subjected to secondary change and decline because of the disturbed typical energy and matter fluxes at the autotrophic level. Plankton blooms have become more frequent, bringing about transient anoxic and hypoxic conditions that are fatal to most benthic communities. Transformation of nekton communities follows, caused by persistent organic substances, heavy metals, oil and other pollutants supplied to the Black Sea. The above transformations and the destroyed coastal spawning areas produce in turn a harmful reduction of fish and dolphin's numbers.

An illustrative example of outbreak of species abundance is provided by the medusa *Aurelia aurita* , which in some years yielded raw biomass of 400 - 600 000 000 t/yr. These outbreaks affect all trophic levels and, primarily, fish. Fish larvae become prey, other age-classes and adults are short of fodder zooplankton. Later, an immigrated species *Mnemiopsis Leidyi* did replace *Aurelia aurita*, owing to a more rapid sexual maturation, a greater number of generations per year and to the absence of predators. At present, density of this dominant amounts to 1 - 1.5 kg/m2 in the Black Sea. *M. Leidyi* is extensively grazing on fodder zooplankton, larvae of molluscs and fish, which causes a substantial reduction in fish numbers, for instance in anchovy.

Thus, a substantial anthropogenic load and a lesser ecological resistance are responsible for the gravest transformations of ecosystems in the Black and Azov Seas, compared to the Baltic and Mediterranean Seas.

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Meso-scale dynamics of the Black Sea and exchanges with the Mediterranean

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The Black Sea Circulation is dominated by a coherent current system along its periphery, i.e. the 'rim' current, and meso-scale eddies and meandering motions superposed onto this basic pattern. The influence of buoyancy input into the northwestern shelf by major rivers, among which the Danube is the largest, contributes to the instabilities of the rim current, which transports the river inputs along the periphery of the western Black Sea. Another mechanism generating intense meandering is the interaction with the abrupt topography of the Sakarya canyon along the Southwestern shelf area, near the Bosphorus. Strong cross-shelf exchanges driven by these mechanisms redistribute the lateral fluxes originating from the major rivers and straits which contribute significantly to the budget of water, nutrients, organic and inorganic particulates and pollutants. A synthesis of the scales and signatures of these circulation features is made, based on oceanographic surveys and satellite data.

The two-layer flows through the Bosphorus determine the fluxes transported to the Black Sea by the 'Mediterranean effluent', and those exported out into the Marmara Sea. Estimates of the fluxes for a number of important properties are made, based on long-term measurements in the region.

Investigations of the spreading of the Mediterranean effluent into the Black Sea have shown a very particular pattern of boundary mixing. The Mediterranean water first spreads on the shelf and becomes diluted by entraining the overlying Cold Intermediate Water, then descends the continental slope, where it generates a pattern of intrusions and secondary circulations up to a depth of 500m, aided by the double diffusive ambient environment and the temperature-salinity anomalies of the sinking slope water. This in turn sets up a larger scale vertical circulation contributing to the interior mixing. The cross-shelf exchanges determine the domain of influence of the intrusions. The filaments of anomalous water thus spread horizontally into the interior carrying the fluxes, various properties with them.

"Towards a Black Sea Action Plan"

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Introduction

The importance of the economic, social, health, and recreational values of the marine environment of the Black Sea. Special hydrological and ecological features of the Black Sea; the adverse effect of the Danube and other major rivers flowing into this semi-enclosed sea. The critical state of the health of the Black Sea.

The development pressures on the management of coastal areas and the need for an integrated environmental policy and adjustment of environmental quality to development requirements through regional co-operative action.

The Convention on the Protection of the Black Sea Against Pollution (adopted in April 1992 in Bucarest as a legal basis for a regional co-operation).

The main components of a Black Sea Action Plan (BAP) : legal framework for regional co-operation; coordinated measures against major sources of pollution; research and monitoring; coastal areas management programmes; institutional and organizational matters; co-operation with Danube and Mediterranean States ; relations with competent international organizations, and in particular UNEP-OCA/PAC Regional Seas Programme.

The elaboration of BAP should take into account the experience of existing regional seas programmes, especially the Mediterranean Action Plan and its component the Blue Plan.

I. Objectives and general principles of a Black Sea Action Plan

Immediate and long-term objectives: prevent, reduce and control of pollution; conservation of living resources, restoration of the ecological balance. Comprehensive character of legal, administrative and technical measures. Elaboration of additional Protocols, Annexes and other instruments having priority over bilateral arrangements.

Adoption and implementation of precautionary principles along with liability for damage, introduction of Best Environmental Practice and Best Available Technology. Implementation of general principles of international environmental law, including applicable rules and guidelines adopted by UNCED.

II. The legal components of the Action Plan

The Convention on the Protection of the Black Sea Against Pollution and the attached instruments as a comprehensive legal framework for regional cooperation.

The obligations of the Black Sea States under other international conventions and treaties relating to pollution of the marine environment and conservation of its living resources.

III. Co-ordinated measures against pollution of the marine environment of the Black Sea

1. Land-based sources of marine pollution

Implementation of the Protocol on Protection of the Black Sea Marine Environment Against Pollution from Land-Based Sources. The significance of the Montreal Guidelines for the Protection of the Marine Environment Against Pollution from Land-Based Sources of 24 May 1985, the conclusions and recommendations of the Meeting of Senior Government Officials Experts convened by UNEP in Rio de Janeiro (30 October - 2 November 1991)Annex II on Marine Pollution from Land-Based Sources) and decisions and recommendations of UNCED in this field.

Practical measures and remedies.

2. Pollution from vessels. Implementation of the Protocol on Oil Pollution to the Black Sea Convention. Application of the relevant provisions of MARPOL 1973/1978 and related instruments.

3. Pollution from dumping and hazardous wastes in TRANSBOUNDARY movement. Implementation of the Protocol on the Protection of the Black Sea Against Pollution by Dumping, the Protocol on Co-operation in Combatting Pollution of the Black Sea Marine Environment by Oil and Other Harmful Substances, Annexes I, II, and III and Resolution 1 on transboundary movement of hazardous wastes and cooperation in combatting illegal traffic thereof. The significance of the London Dumping Convention of 1972 and the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal of 1990.

Coordinated legislative, administrative and technical measures to be envisaged in the Action Plan.

4. Pollution of the marine environment from or through the atmosphere. Harmonization of national rules, regulations and standards.

5. Pollution form sea-based activities under national jurisdiction. Cooperation in the elaboration of relevant regional instruments taking into account the specific geophysical and geochemical features of the Black Sea.

6. Cooperation in combatting pollution in emergency situations. Implementation of the provisions of the Protocol on Cooperation in Emergency Situations and the relevant Annex, attached to the Convention on the Protection of the Black Sea Against Pollution. Cooperation with States from the Mediterranean and Danube River basin.

7. Reporting and exchange of information, environment impact assessment and analysis and other data relating to cooperative action against pollution. Improving communications among governments, experts, and scientists in the Black Sea countries.

IV. Marine science and monitoring programme

The scientific components of the Black Sea Action Plan Regional Coordination of national Black Sea and monitoring programmes. Elaboration of a coherent medium-term marine science and monitoring programme, taking into consideration the conclusions and recommendations of the International Workshop on the Black Sea, held in Varna, Bulgaria, 30 September - 4 October 1991. Coordination of the marine science programmes and conducting of joint scientific cruises.

V. Regional cooperation in the management of coastal areas of the Black Sea

Cooperation with the view to harmonize the environmental policies of the Black Sea States. Establishment of common rules, regulations, standards and recommended practices and procedures for economic planning and sustainable development and environmental protection. Involvement of private and public sectors in providing economic incentives for an integrated environmental and development considerations.

VI. Institutional and organizational arrangements

Establishment of the institutional and organizational framework in accordance with the provisions of the Black Sea Convention, including subsidiary bodies of experts and ad hoc study groups on specific issues. Constitution of coordinating unit, taking as a model the Mediterranean Action Plan. Powers and functions of the Meetings of the Contracting Parties.

VII. Cooperation with states from the Mediterranean and Danube river basin

Exchange of information. Participation in the meetings of the governing and subsidiary organs. Implementation of Resolution 2 on cooperation with Danube States. Examination of the problem of adopting appropriate instrument for cooperation with the Mediterranean States.

VIII. Cooperation with competent international organizations

Establishing close working relations and cooperation with competent international organizations within the UN system (such as IMO, FAO, IIOC, UNESCO, WMO, UNIDO, UNDP, WHO, and others) and other international and regional institutions. Implementation of Resolution 3 on the establishment of close cooperation with UNEP - Ocean and Coastal Areas/Programme Activity Center (UNEP/OCA/PAC), Regional Seas Programme, particularly concerning the elaboration of a Black Sea Action Plan, providing technical assistance and equipment, training of specialists, transfer and use of best available clean and low-waste technologies, etc.

Conclusions

The elaboration of a Black Sea Action Plan is the most essential device for the implementation of the Convention and promoting regional cooperation. This plan should identify the priorities for concerted action, taking into consideration the experience of other regional seas programmes and the conclusions and recommendations of UNCED for environment and sustainable development applicable to the Black Sea area.

Assessing trends in marine pollution : Are the data good enough ?

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The assessment of levels and trends of chemical contaminants in the marine environment is an essential component in any strategy to control and abate pollution. The practical application of all experimental or monitoring data depends upon their quality measured in terms of accuracy and precision. Data Quality Assurance (QA) programmes have the aim of making sure that the measurements are good enough for a particular purpose (such as for food safety or studying long-term trends). Quality control (QC) programmes are designed to maintain the data to a sufficient quality and assure their comparability between different laboratories using different techniques.

Intercomparison exercises on marine samples, first performed in the late 1960's, revealed large disparities in the results obtained by different laboratories. At about the same time, analytical techniques began to improve. "Best estimates" of trace metal concentrations in oceanic seawater, for example, decreased dramatically with time as analytical accuracy improved (3 orders of magnitude for lead in 4 decades, 1 order of magnitude for mercury in one decade). As a consequence our perception of what are "real" and "apparent" pollution problems also changed dramatically.

From the early 1970s, regular intercomparison exercises were organized on a World-Wide and regional scale by the Monaco Laboratory of IAEA (the International Atomic Energy Agency) frequently in cooperation with UNEP (the United Nations Environment Programme), and occasionally with IOC (the Intergovernmental Oceanographic Commission of UNESCO). In parallel, ICES (the International Council for the Exploration of the Sea), organized regular exercises between countries in the Baltic, North Sea and North Atlantic regions. These two data bases, covering organic and inorganic contaminants and radionuclides in sediments, water and biota, have served as a barometer to test the current status of data quality in pollution monitoring programmes. Despite considerable improvements in data quality, the data for some basic parameters remains surprisingly poor. For example, in a recent 24 laboratory World-Wide exercise on sediments the coefficient of variation for total petroleum hydrocarbons (as the fluorimetric chrysene equivalent) was 74%. In other words, measurements of 200 µg/g and 800 µg/g would be statistically indistinguishable from one another! On the other hand the coefficient of variation for plutonium, mercury or some PCB congeners is now below 20%, a remarkable achievement.

If a major objective of regional monitoring programmes is to detect long-term pollution trends (to see, for example, whether new legislation is effective) then the precision of the data must be much better than the expected environmental variation. Intercomparison exercises alone are insufficient to ensure data quality, as quality control is a continuous process which is a basic facet of the work of any credible environmental laboratory. Unfortunately, many laboratories are still not prepared to accept this common responsibility and their data are often inadmissible for regional and global marine pollution assessments. In the Mediterranean, the Mediterranean Action Plan, with the support of the Marine Environmental Studies Laboratory of IAEA-MEL and the World Bank, has initiated a concerted effort to improve data quality. This includes training of technicians, intercomparison exercises, the provision of reference methods and materials, joint monitoring exercises, equipment supply, installation and maintenance and regular methodological workshops. Data from the MEDPOL programme will then be used to prepare regular reports of "levels and trends" of marine contamination. The ultimate objective of the programme is to provide the Mediterranean countries with a valid scientific basis for managing the marine environment and to effectively control and abate marine pollution and assure the harmonious sustainable development of marine resources in the future.

The present report critically assesses progress on data quality assurance, future challenges and current obstacles for resolving them.

The scientific background for the control of coastal eutrophication

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Following any dramatic eutrophication crisis, such as the huge H_2S production by decaying ulvae in Venice lagoon (August 1988) or the extensive formation of mucilage by phytoplankton along the Emilia-Romagna coast in July 1989, the question of scientific recommandations for optimal restoration of eutrophicated waters comes again to the surface, such as a mythic Loch'Ness monster... In fact, a well-documented description of the various stages and consequences of marine eutrophication came out of the previous meetings, workshops or conferences on the subject (*e.g.* for the Mediterranean: the UNEP Workshop at Bologna (Italy), 2-6 March 1987, the International Conference on Marine Coastal Eutrophication at Bologna, 21-24 March 1990, the EEC Workshop on Eutrophication-related phenomena at Roma, 28-30 May 1990...). Despite this scientific knowledge, little improvement seems to have been gained in the control of marine eutrophication, which spreads over increasing areas, according to the growing loadings of nutrients coming from land drainage and urban wastes. At this point, at least two questions arise: 1) Are the scientific programmes really focused on the aspects of the eutrophication phenomenon which are pertinent to its control ? 2) Does a real will exist in the scientific community as well as in the decision-makers sphere to build cost-effective, testable and hence, refutable restoration experiments ?

Concerning the first point, it seems of prime importance to determine which is the most efficient controlling nutrient (*i.e.* the most limiting one) and how much it has to be reduced. As pointed out by several authors (STIRN, 1988; HECKY and KILHAM, 1988), no universal agreement could be reached about the nutrient limiting the marine primary production, in contrast to the inland waters, where phosphorus has been identified. This lack of generality is partly due to the natural heterogeneity of marine waters: for instance, the mean N/P ratio for the whole Mediterranean Sea is significantly higher (19) than in the oceans (≅16). But contradictory and confusing results have been -and are still- reported, due to inappropriate use of N/P ratios in determining the most limiting nutrients: the phytoplankton growth is a dynamic process governed by fluxes of nutrients, not by instantaneous concentrations in surrounding waters. It looks as if the dynamic vision of algal growth gained twenty years ago by the physiologists using chemostats would still be ignored by ecologists working at sea: does a physiologist infer the state of nutrient limitation of his culture from the residual concentrations of nutrients in his chemostat ? As a consequence, it seems important to promote the use of techniques measuring the "point of view" of algae, *i.e.* determination of internal quotas of N and P or bioassays, which are an indirect way of measuring the fluxes of nutrients effectively available to the algae. Supposing that the limiting nutrient could be determined without any doubt, the question remains about how much it is necessary to reduce the loadings to get an appreciable effect on the system. As VOLLENWEIDER pointed out for lakes, the residence time of water in the system is the main parameter controlling the effective transformation of inorganic nutrients into algal living matter, just as in chemostat (DROOP, 1975). Instant is the need for good calculus of residence times in open coastal systems, which requires the determination of the water volume to be considered, as mentioned by LEE and JONES (1981), and a good knowledge of lagrangian residual drift (MENESGUEN and SALOMON, 1988). No reliable estimation of the acceptable level of nutrient loading can be computed without a detailed hydrodynamic background.

The second point is not a scientific one, but a psychological one. On the one hand, scientists too often take refuge behind the argument of freedom and non-profitability of the so-called "fundamental research" to avoid the danger -but also the honor- of deducing from their scientific knowledge clear and operational (*i.e.* quantitative) recommandations. It is a singular paradox that, under the cover of science, a lot of studies precisely avoid the decisive phase of testing (or refuting) their theory by experimenting in the real world, which is the only way to progress in science. On the other hand, it is also quite clear that decision makers, politicians and administrations are not always prepared to agree with scientific results and recommandations which do not fit in their planning. A good example is the controversy on the phosphate loading reductions in coastal areas where nitrogen limitation has undoubtly been established : decision makers argue on the effective role of phosphorus in triggering the eutrophication in inland waters to justify massive dephosphatation of urban sewages in these coastal areas, which is far easier than promoting reduced nitrogen fertilization on the corresponding watersheds (D'ELIA and SANDERS, 1987; MENESGUEN and SALOMON, 1988).

As a conclusion, one can say that a step forward in reducing coastal eutrophication could be obtained if all the partners would first go beyond their own psychological gap, and then bring some technical improvements.

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Genetic structure of *Corallium rubrum* L. 1758 populations from the Tyrrhenian Sea

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At the FAO Technical Consultation on Red Coral of the Mediterranean (AA. VV., 1989) the existence of differences in skeletal structures, colouring and growth rate among red coral colonies were pointed out. Differences in morphological types may be related to environmental gradients or genetically determined. Population genetics studies have been used extensively to reveal the genetic affinities among populations (WARD, 1989). In order to obtain a preliminary characterization of the *Corallium rubrum* genetic structure, two Tyrrhenian populations were analyzed by means of enzyme electrophoresis.

C. rubrum specimens were collected at Calafuria cliff (Leghorn) and Elba Island by SCUBA diving. Each coral colony was considered as an individual, because of its origin from a single planula larva (VIGHI, 1972). Only organic material (polyps and a little coenosarc) was used for the electrophoretical analysis. Electrophoretic techniques have been assayed for 12 enzymes. Migrations were performed on cellulose acetate media (ABBIATI & MALTAGLIATI, in press). Banding patterns enabled the calculation of allelic and genotypic frequencies for thirteen loci. Genetic variability of each population was expressed in terms of polymorphism (0,99% and 0.95% criteria), observed and mean heterozygosity, mean number of alleles.

In both samples the same alleles, showing different frequencies were found. In the Calafuria sample three loci were polymorphic at 0,95 criterion and one at 0.99, while in the Elba sample four loci resulted polymorphic at 0,95 and one at 0,99 criteria, the eight further loci being monomorphic. In the Elba sample polymorphic loci had a more even genetic variability than in the Calafuria one, as shown by Standard Error (SE) values (Tab. 1).

Table 1. Summary in genetic variation of *Corallium rubrum* populations (SE in parentheses).

Population	Mean sample size	Mean number of alleles	% Polymorphic loci(99)	% Polymorphic loci(95)	Observed heterozygosity	Mean heterozygosity
Calafuria	91.1	1.46 (0.18)	30.77	23.08	0.085 (0.041)	0.104 (0.054)
Elba	76.3	1.46 (0.18)	38.46	30.77	0.064 (0.029)	0.073 (0.035)

The mean heterozygosity of both populations agrees with the average invertebrate value (AYALA & KIGER, 1987). A slight difference, not significant by T-test, was observed in the mean heterozygosity values of the two samples.

In literature there are very few data about genetic variability in Anthozoa and most of them concern reef corals. In order to compare our data with those regarding *Pocillopord damicornis* (STODDART, 1984) the mean heterozygosity in polymorphic loci was calculated (Tab.2). Genetic variability of *C. rubrum* resulted lower with respect to the reef coral. An explanation could be differences in the life cycles of the two species. *C. rubrum* eggs develop in the coelenteron and the planulae do not have a large dispersal capability. *P. damicornis* too has brooded planulae, but with over 100 days of planktonic life, sufficient to allow dispersal over large distances (RICHMOND & HUNTER, 1990). Moreover, *P. damicornis* samples analyzed by STODDART came from larger populations then our *C. rubrum* samples; this characteristic is of great importance in maintaining the presence of rare alleles (NEVO *et al.*, 1984).

Table 2. Mean heterozygosity of polymorphic loci in *Corallium rubrum* and in three populations of *Pocillopora damicornis* (STODDART, 1984).

Corallium rubrum		*Pocillopora damicornis*	
Calafuria	0.27	Pocill. Reef	0.35
Elba	0.19	Mary Cove	0.44
		Little Island	0.35

Our data represent a first characterization of *C. rubrum* population genetics. An extension of these studies to further Mediterranean samples is required in order to give a more exhaustive picture of the level of populations structuring.

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Preliminary Observations on benthic communities in a Submarine cave influenced by hydrothermal springs

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Typical submarine caves exhibit very poor and scattered benthic communities (CINELLI *et al.*, 1978; BALDUZZI *et al.*, 1989), with gradual decrease in species numbers and organism cover along the outside-inside gradient (GILI *et al.*, 1986). Absence of light and poor water exchanges are considered as the major reasons for oligotrophy and severe reduction in organism cover and biomass (FICHETZ, 1990).

The Grotta Azzurra marine cave opens in the carbonatic rock of Capo Palinuro (Tyrrhenian Sea). The cave has a volume of about 120000 m^3 and a maximum depth of 33 m (ALVISI *et al.*, in press). A peculiarity of the Grotta Azzurra is the presence of underwater sulphurous springs which form a thermo- and chemocline below the roof of the cave.

Preliminary surveys in the Grotta Azzurra led to the identification of 5 major biological zones (fig.2):

1- immediately outside. Photophilic algal assemblages, dominated by *Dictyota dichotoma*, occur;

2- entrance. Light is severely reduced and crustose coralline species are present;

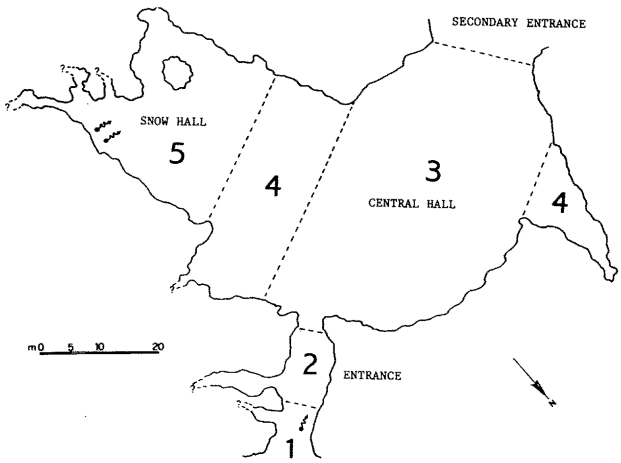
3- central hall. It is virtually dark. Dense faunal assemblages are dominated by passive filter-feeders like *Eunicella cavolinii* and *Eudendrium* sp. This might be explained by efficient water exchanges;

4- completely dark belts. Organism cover is reduced and fauna impoverished as typical of caves with a complete confinement gradient;

5- "Sala della Neve" (Snow Hall). It is the innermost part ot the cave, completely dark and extremely confined in terms of hydrodynamic conditions and trophic alloctonous inputs. Warm sulphur-rich waters accumulate to the vault where a complex of *Beggiatoa*-like filamentous forms and gelatinous colonies develop. White flakes of organic matter detach from the bacterial mats and fall to the bottom. Below, very rich and dense faunal assemblages occur on both the walls (sponges, bivalves, scleractinia) and the sediment floor (sabellid polychaetes, *Pinna nobilis, Antedon mediterranea, Ophioderma longicaudum*). Estimated biovolumes of specimens of the sponge *Geodia cydonium* and of the scleractinian coral *Astroides calycularis* resulted significantly larger for organisms collected here than in other parts of the cave.

These data provide a strong proof of enhanced trophic conditions, in contrast with the cave trophic depletion hypothesis.

Fig. 1. Biological zonation in the Grotta Azzurra: for explanation see text. (Plan of the cave redrawn from ALVISI *et al.*, in press)



It appears that the unusual launal richness of the Grotta Azzurra is correlated with the presence of sulphide springs. Areas interested by chemosynthesis, in fact, appear to be biologically complex and very productive habitats (TARASOV *et al.*, 1990). Preliminary analysis of stable carbon isotopes by Dr. M.C. Kennicutt of Texas A. & M. University in organisms collected from the Sala della Neve seem to support this hypothesis (SOUTHWARD & SOUTHWARD, 1992). More investigations will be carried out during future research, which will assess organic carbon fluxes in the cave and trophic transfers to the benthos.

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Metapenaeus stebbingi nobili Shrimp in lake Quarun, Egypt

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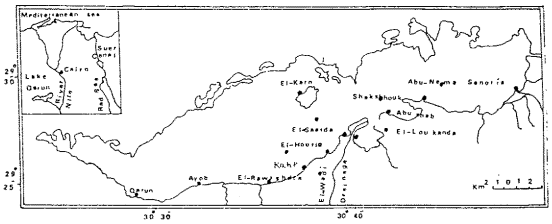
Lake Qarun is a saline land-locked lake, located in Al Fayoum depression in the western desert of Egypt (Fig. 1). It is shallow with a mean depth 4.2 m. Only 18% of its area has a depth ranging from 5 to 8 meters.The average S% has increased due to evaporation from 11.1% (in 1906) to 32.5% (in 1928) but is expected to remain unchangeable) until the middle of the next century (SOLIMAN, 1989). Transplantation of marine fishes started in 1928 by introduction of mugilids, then 1935 by *Solea vulgaris* and finally with shrimp postlarvae in 1977 & 1980 and later the stocking program for shrimp was stopped. Shrimp species were acclimatized well during the following period as reported by ISHAK *et al.*, 1980. Prawn production increased steadily from 2.4% in 1984 to 36.2% in 1990 of the total lake production. *M. stebbingi*, in particular, increased from 1.7% in 1979 to 30% in 1984 and then reached to 100% of total prawn landings of the lake in 1989 (ABDEL RAZEK, 1991). *M. stebbingi* has formaly proved its efficiency as a shallow water species with apparently great tolerance to markedly high salinities in Suez Canal Lakes (GAB-ALLA *et al.*, 1990) and this is considered an important reason for its succession in Lake Qarun.

More than 77% of *M. stebbingi* catch was landed at El-Loukanda, Shakshouk, El-Saaida and Abu-Shanab centers, east of the lake, were S% 30-31% and bottom is sand and sandy mud. While in western part Kahk and El Rawashdia are the most productive with regards to shrimps.

The maximum size recorded of *M. stebbingi* in Lake Qarun was 12.0 cm for females and 11.0 cm for males which proves a considerably optimal environmental conditions for its growth in comparison with other habitates. The results show the estimated minimum size for mature female of *M. stebbingi* in Lake Qarun to be 8.3 cm T.L which is the minimal biological size for maturation compared with other areas of occurrence. In Lake Qarun *M. stebbingi* showed a clear breeding season over a period from June to October and the recruitments appeared from August to October.

Unfortunately, the active period of *M. stebbingi* spawning as well as the higher occurrence of its newly born groups, coincided with the intensive period of fishing in the lake (July-October). This system causes a drastic effect on the abundance of mother shrimps as well as juveniles, this seriously affecting the shrimp fishery of the lake. For this reason, much attention has to be given to the fishing periods, as well as fishing gears used, for good management of shrimp fishery in Lake Qarun.



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Prosobranch community from the *Posidonia oceanica* "Reefs" in the Stagnone Lagoon (Marsala, Sicily)

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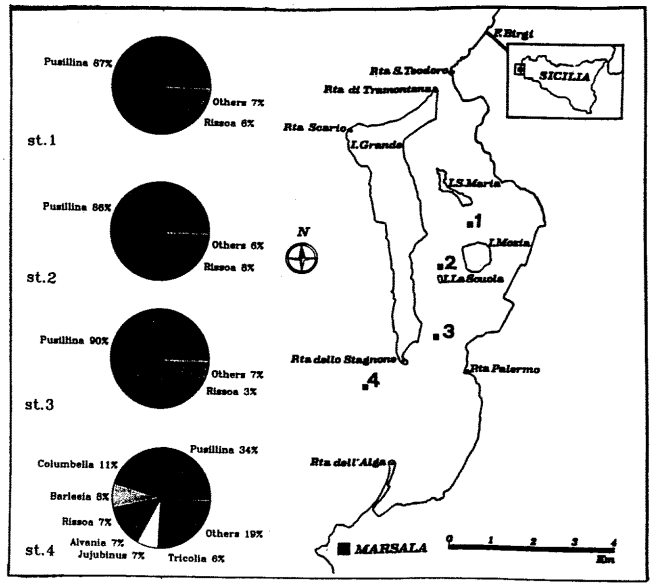
The Stagnone near Marsala is the biggermost sound of the Sicily. It can be subdivided in two basins; in the northern one, with major lagunar characteristics as low water movement and high sedimentation rates, the seagrass *Posidonia oceanica* grows till the surface on a thick "matte" layer. Typical "reefs" are therefore build up by the plant, displaced to form a number of parallel "cordons" (CALVO & FRADA'-ORESTANO, 1984). In the middle part of the basin (between the islands of Mozia and S.Maria) "cordons" became strongly arched to form a number of "atolls". The aim of the present study is to analize the colonization of such peculiar formations by the Mollusca Prosobranchia, a faunal group among the most representative and well adapted to the *Posidonia oceanica* leaf stratum.



Sampling has been performed in july 1990, in 4 stations at a depth of about 0,5 m, arranged along a N-S (inward-outward lagoon) transect (Fig.1). A total of 3.541 individuals, belonging to 40 species of Prosobranchia have been collected, utilizing the hand-towed net technique (RUSSO & VINCI, 1991).

An overall view of the structural trend concerning the malacological community can be given by the analysis of the quantitative dominances along the transect. It is evident that in the most "marine" station (st.4) the individuals are better shared out amog many genera. On the contrary in the lagoon (st. 1, 2, 3) the Rissoidae of the genus *Pusillina* are strongly dominant (more than 85% in each station). An increasing presence of *Rissoa auriscalpium* also occurrs (Fig. 1).

At least 4 taxa of Pusillina can be distinguished (*P. cfr. radiata, P. cfr. lineolata, P. cfr. philippi* and *P. cfr. incospicua*); however the shell variability is so high that the determination at species level is very difficult. It is reasonable to speculate that the Stagnone could be a sufficiently isolated site, with peculiar edaphic characteristics, where speciation processes are more effective (CHEMELLO & RIGGIO, 1990). The high variability in the populations of *Pusillina* species seems to support such speculation, besides to open new interesting fields of investigations, involving functional morphology and population genetics.

Among the other strong changes occurring in the lagoon, it is also worth noting that in the family Trochidae the species *Jujubinus striatus*, abundant in the marine station, completely desappears, while *Gibbula umbilicaris*, typical of shallow and exposed *Posidonia* beds (e.g. st.4), is mainly replaced in the sheltered "reefs" by *Gibbula adansoni*.

No differences between "cordons" and "atolls" have been noticed as far as the colonization by Prosobranchs.

On the whole the paramount dominance of Rissoidae, and in particular of the very controversial taxa of the genus *Pusillina* (cfr. VERDUIN, 1976), is a further evidence that the Stagnone, and its peculiar benthic formations as the "reefs" of *Posidonia oceanica*, is a rare and important marginal environment, suitable for studies on ecological segregation, population adaptative variability and speciation processes of the marine organisms.

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Sediment impact on algal macrobenthic communities : an experimental approach

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The vertical flux of particulate matter from the pelagic to the benthic system is the result of a delicate balance, controlled by biological and physical-chemical factors, between supplies and losses of material in the water column (fig.1). Human activities can alter the sedimentation rate by directly or indirectly increasing the amount of suspended material. Increment of water turbidity has been observed in many coastal areas, with grave consequences for benthic organisms (LUMB, 1990).

Great efforts have been made to assess and quantify vertical transport and spatio-temporal dynamics of particulate matter in many coastal and oceanic areas. Sediment traps have proved to be a suitable and inexpensive instrument to provide information about vertical fluxes, even if possible sources of bias are inherent to this methodology (SMETACEK, 1984).

Adequate knowledge of interactions between sedimentation and benthic communities are lacking so far. Laboratory experiments and field observations have shown that sediment instability, burial and scour may represent a source of stress and disturbance for algal communities, by removing whole organisms or part of them, by preventing settling of spores or recruitment of recently settled algae, by reducing inputs of light and oxygen and substratum availability (DEVINNY & VOLSE, 1978; TAYLOR & LITTLER, 1982). These effects are difficult to quantify and to date only very few field experiments have been performed in subtidal habitats.

We propose an experimental manipulative approach to study the effects of sediment deposition on the structure or rocky bottom subtidal macroalgal communities. The research is being carried out on a 15m-deep rocky bottom at Calafuria (Tyrrhenian Sea), a locality characterized by high levels of turbidity. Previous studies on algal community of the area were carried out by CINELLI (1969).

Preliminary surveys of the experimental area have shown a poorly diversified algal community, dominated by filamentous turfing algae (*Polysiphonia* spp.) and by crustose coralline algae. Both kinds of algae are resistant to sediment burial and scour (KENDRICK, 1991). Our experiment tests the null hypothesis that the structure of the algal community is unaffected by variations in rates of sediment deposition and scour. The experimental units are 12/400 cm2 squares, randomly assigned to 6 treatments and 6 control replicates. Sedimentatioll is reduced in treatment plots by means of transparent Plexiglas roofs, while it is ullmanipulated in controls. The same experimental design is used to study the effect of sedimentation on algal recruitment: the experimental units are 12/400cm2 squares scraped clean from resident organisms. Community dynamics and algal recruitment are surveyed with non-destructive techniques. A pilot study is in progress to test any artifact induced on light penetration and hydrodinamism by roofs. The sedimentation of the area is investigated using cylindrical sediment traps and sanded Plexiglas plates. Hydrodinamism, light penetration and physical-chemical parameters of the water column are also periodically measured.

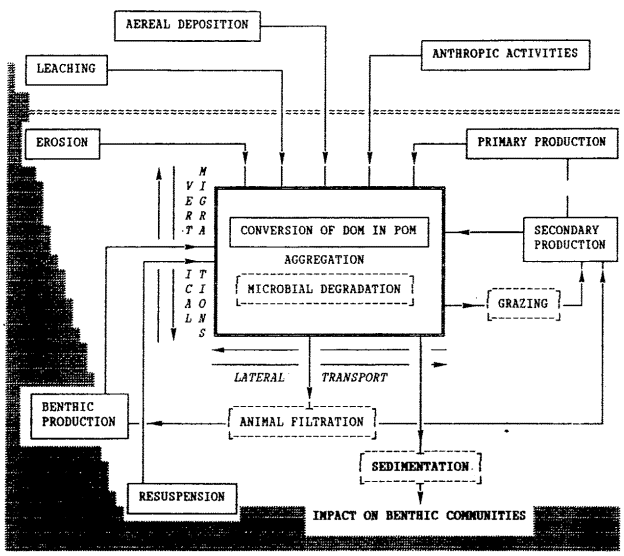

Fig. 1 - Scheme of fluxes of particulate matter in marine ecosystem.
——— processes producing particulate matter
-------- processes removing particulate matter
===== pool of suspended particulate matter

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Dynamique de la calcification chez le corail rouge, *Corallium rubrum*

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Espèce typiquement méditerranéenne, bien que présente aussi en quelques points de la façade atlantique, le corail rouge (*Corallium rubrum* Linné, 1758) fait l'objet depuis les temps préhistoriques d'une pêche intensive en raison de son utilisation en bijouterie (LIVERNO, 1983). Malgré sa haute valeur économique, la biologie du corail rouge est encore peu connue, et l'ouvrage de référence reste encore à l'heure actuelle l'"Histoire naturelle de corail" de LACAZE-DUTHIERS (1864).

Dans le cadre d'une étude des mécanismes de biocalcification chez les invertébrés marins, le Centre Scientifique de Monaco a entrepris l'étude particulière de la calcification du corail rouge de Méditerranée par une approche multidisciplinaire : morphologique, physiologique et biochimique (ALLEMAND et GRILLO, 1990, 1992, GRILLO et ALLEMAND, 1990, GRILLO *et al.*, soumis). Parmi les résultats obtenus, l'un des plus importants a été la mise en évidence de l'existence d'un épithélium axial entourant le squelette et vraisemblablement à l'origine de sa formation (GRILLO et ALLEMAND, 1990; GRILLO *et al.*, soumis). L'existence de cet épithélium pourrait remettre en cause l'hypothèse de formation de l'axe central du corail émise par LACAZE-DUTHIERS (1864), qui suggérait que cet axe résultait uniquement de la migration puis de la fusion des spicules présents dans la mésoglée en un ciment calcaire. Cette hypothèse, depuis reprise dans tous les manuels de zoologie, se trouve à la base de la classification du corail rouge au sein des gorgonacés (BAYER, 1956). Afin de résoudre ce problème, la présente étude concerne la dynamique de la calcification du corail abordée grâce à l'utilisation de radioisotopes. Les résultats présentés suggèrent que l'hypothèse de LACAZE-DUTHIERS ne s'applique pas à l'ensemble de la colonie pour laquelle la formation de l'axe et des spicules sont deux phénomènes séparés.

Deux aspects de la dynamique de la calcification d'une colonie de corail rouge ont été étudiés, (1) la dynamique de croissance des structures squelettiques de la base au sommet (dynamique spatiale) et (2) la dynamique de croissance des différentes structures squelettiques les unes par rapport aux autres à un niveau de la colonie donné (dynamique temporelle).

Pour aborder le premier point, les structures squelettiques ont été marquées soit à l'aide de ^{45}Calcium, soit à l'aide de ^{14}C-acide aspartique (^{14}C-Asp), acide aminé majoritaire dans la matrice organique intrasquelettique du corail rouge (résultats non publiés). Des colonies entières d'environ 5 cm ont été incubées pendant 24 h en présence de l'isotope. Après rincage et traitement des échantillons (voir Matériels et Méthodes dans ALLEMAND et GRILLO, 1992), la radioactivité est mesurée dans les trois compartiments, tissus, spicules et squelette axial, après section de la colonie en tranches d'environ 1 cm. Les résultats obtenus en comparant les deux isotopes sont concordants en ce qui concerne la croissance du squelette : dans les deux cas le taux de croissance, maximal à la base décroît linéairement vers l'apex de 20 à 40 %. Ce résultat suggère que la croissance de la colonie est plus rapide en épaisseur à la base qu'en longueur à l'apex. En ce qui concerne les spicules, les résultats divergent suivant que l'on utilise le ^{45}Ca ou le ^{14}C-Asp. L'utilisation de ^{45}Ca montre que le taux de croissance des spicules est plus important à l'apex qu'à la base et présente un minimum dans la partie médiane de la colonie. Les mêmes expériences réalisées avec ^{14}C-Asp montrent un maximum d'incorporation dans la partie basale de la colonie avec une décroissance linéaire jusqu'à l'apex d'environ 50 à 60 %. Ces résultats suggèrent que la proportion de matrice organique n'est pas constante de la base à l'apex de la colonie. De plus, contrairement à ce qui est observé pour d'autres octocoralliaires (comme la gorgone, Leptogorgia, étudié par KINGSLEY et WATABE, 1989) ou pour les coraux scléractiniaires (PEARSE et MUSCATINE, 1971) où un gradient de calcification a été observé avec un maximum à l'apex, la croissance du corail rouge semble différente et paraît plus homogène. L'apex n'y représente pas un site de calcification privilégié.

La dynamique temporelle de la croissance des structures squelettiques a été étudiée en réalisant des expériences de chasse isotopique. Les colonies sont incubées en présence de ^{45}Calcium pendant 24 h. Le lot est ensuite partagé en deux : la première moitié est traitée immédiatement alors que la seconde moitié est mise à rincer dans l'eau de mer courante pendant 1 semaine. Après ce temps, les colonies sont traitées de façon similaire au premier lot. Dans les deux cas les colonies sont tronçonnées en section d'environ 1 cm. La répartition de la radioactivité dans les différents compartiments est alors comparée. Les résultats sont rapportés dans le tableau ci-dessous.

	APEX		BASE	
	24 h	1 sem	24 h	1 sem
Tissu	18 %	13 %	17 %	13 %
Spicules	63 %	55 %	54 %	60 %
Squelette	16 %	32 %	29 %	27 %

Il ressort de cette comparaison que la partie apicale (1 cm max à partir de l'apex) se comporte de façon très différente par rapport au reste de la colonie: à l'apex, le pourcentage de radioactivité incorporé dans la fraction squelettique augmente de façon importante après une chasse d'une semaine au détriment des deux autres compartiments, spicules et tissus. Dans la partie basale de la colonie, on constate que le compartiment axial ne varie pratiquement pas au cours du temps. La fraction spiculaire augmente très légèrement au détriment des tissus.

Ces résultats suggèrent que dans la partie apicale le squelette axial résulte en partie de la fusion de spicules déjà formés. Cependant, ce mode de synthèse de l'axe n'est pas le seul opérant puisque nous avons montré par ailleurs (ALLEMAND et GRILLO, 1992) que la synthèse de ce squelette était parallèle de la synthèse des spicules. Par contre, les présents résultats montrent que dans tout le reste de la colonie (appelée ici "base"), la fusion de spicules ne semble pas participer à l'élaboration du squelette axial, contrairement à l'hypothèse généralement admise. Ces résultats confirment l'hypothèse émise à la suite de l'étude ultrastructurale des formations squelettiques et des tissus associés (GRILLO *et al.*, soumis). Ils remettent ainsi en cause la classification actuelle du corail rouge au sein de l'ordre des gorgonacés. En effet, le sous-ordre des Scleraxonia, dans lequel le corail rouge a été classé à la suite des travaux de LACAZE-DUTHIERS, est caractérisé par le mode de formation de l'axe à partir de la fusion des spicules. Contrairement au sous-ordre des Holaxonia (où le squelette est le résultat de la sécrétion d'un épithélium s'invaginant peu à peu au fur et à mesure de la croissance) le squelette des Scleraxonia est dit interne (BAYER, 1956). L'étude ultrastructurale entreprise par GRILLO et ALLEMAND (1990), montrant que le squelette axial du corail rouge était entièrement recouvert d'un épithélium, ainsi que les résultats présentés ici suggèrent donc que l'appartenance du corail rouge au sous-ordre des Scleraxonia est douteuse, ses caractéristiques le rapprochant plus des Holaxonia, et mérite d'être ré-évalué par les systématiciens.

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Influence du broutage des feuilles sur la composition des faisceaux foliaires de la phanérogame marine *Posidonia oceanica* Delile dans le Parc marin de Carry-le-Rouet (Méditerranée, France)

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En Méditerranée, les herbiers de posidonies (*Posidonia oceanica* Delile) constituent l'une des composantes les plus fondamentales de l'équilibre et de la richesse des fonds marins infralittoraux (AUGIER, 1985).

Au cours d'une mission en plongée dans le Parc marin de Carryle-Rouet, nous avons pû mettre en évidence l'influence du broutage des feuilles sur la composition des faisceaux foliaires de cette phanérogame marine.

Une trentaine de faisceaux orthotropes a été prélevée dans 6 stations différentes entre 2,5 et 5 m. de profondeur et sur une surface ne dépassant pas 5 m. de diamètre. Les prélèvements ont été réalisés au hasard, en coupant un petit morceau de rhizome de façon à garder intact le faisceau et à ne pas endommager l'herbier.

Les faisceaux foliaires ont été ensuite disséqués au laboratoire pour obtenir trois lots différents de feuilles : juvéniles, intermédiaires et adultes. Le critère de taille séparant les feuilles juvéniles des intermédiaires est de 50 mm., les intermédiaires étant distinguées des adultes par l'absence de la ligule. Chaque feuille a été mesurée en mm, tandis qu'était notée l'absence ou la présence de broutage pour l'étude de son influence sur la proportion des feuilles de posidonies.

Les compositions des faisceaux foliaires sont présentées dans le tableau 1 avec les rapports des feuilles broutées sur celles non broutées.

Site	N°T	AB(%)	ANB(%)	AB/ANB	IB(%)	INB(%)	IB/INB	J(%)	TB/TNB
1	185	28	5	5,2	15	40	0,38	11	0,95
2	238	37	2	17,4	7	15	0,46	40	2,58
3	213	33	3	10,0	2	27	0,07	35	1,16
4	207	32	2	13,2	6	21	0,30	39	1,65
5	290	27	4	6,0	14	35	0,40	19	1,03
6	277	34	0	95,0	6	19	0,35	40	2,13

Tab.1 : Composition des faisceaux foliaires de posidonies prélevés dans le Parc marin de Carry-le-Rouet le 26/10/91.
N°T = Nombre Total des feuilles, A = Adulte, B = Brouté,
NB = Non Brouté, I = Intermédiaire, J = Juvénile, T = Total.

Pour vérifier l'influence du broutage sur la composition des faisceaux foliaires, nous avons utilisé le coefficient de corrélation des rangs de Spearman (in CAPERAA et VAN CUTSEM, 1988). Les résultats sont présentés dans le tableau 2.

Les résultats du test d'association utilisant le coefficient de corrélation des rangs montrent une influence incontestable du broutage sur la composition des faisceaux foliaires de posidonies.

Feuilles		AB/ANB	IB/INB	TB/TNB
Adultes	(%)	0,56	-0,13	0,76 *
Intermédiaires	(%)	-0,94 ***	-0,14	-0,96 ***
Juvéniles	(%)	0,99 ***	0,07	0,99 ***

Tab. 2 : Coefficient de corrélation des rangs de Spearman entre les proportions des feuilles et les broutages. * : significative au seuil d'erreur 10%, *** : significative au seuil d'erreur 1%.

Le broutage des feuilles adultes présente une corrélation très forte avec la proportion des feuilles juvéniles et une corrélation négative avec celle des intermédiaires alors que celui des intermédiaires n'a aucune corrélation significative.

Le rapport des feuilles broutées totales sur les feuilles non broutées totales montre une caractéristique semblable au broutage des feuilles adultes sauf pour la proportion des feuilles adultes.

Ces résultats suggèrent que le broutage des feuilles favoriserait l'apparition des jeunes feuilles et accélèrerait la croissance des feuilles intermédiaires, ce qui se traduit par la diminution de la proportion des feuilles intermédiaires et par l'augmentation de celle des adultes. Ce phénomène peut être expliqué par une modification des conditions d'éclairement entraînée par la disparition de l'écran des feuilles broutées se répercutant sur les métabolismes de la plante, au premier plan desquels la photosynthèse. On peut aussi l'expliquer par une levée d'inhibition phytohormonale au niveau du méristème foliaire dûe à l'éradication du sommet des feuilles (PILET, 1961) ou encore par une réaction physiologique directe du méristème basal à l'effet mécanique du broutage. Ces hypothèses ouvrent la voie à un champ expérimental particulièrement intéressant.

D'autre part, signalons que le responsable de la quasi-totalité de ces broutages est un poisson herbivore, la saupe (*Sarpa salpa*), très connu pour sa fréquentation des herbiers de posidonies (BELL et HARMELIN-VIVIEN, 1983) et qui laisse une marque d'incision caractéristique de ses mâchoires sur la feuille.

Enfin, ces résultats indiquent aussi que l'utilisation de la posidonie comme indicateur biologique de la pollution doit tenir compte de ce facteur de broutage qui modifie les caractéristiques du faisceau foliaire.

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Estimation et variations spatio-temporelles de la production de *Spisula subtruncata* (da Costa) (Mollusque Bivalve) de la baie d'Alger.

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L'étude dynamique du peuplement macrobenthique des sables fins de la baie d'Alger a montré l'importance de certaines espèces au sein du peuplement, particulièrement *Spisula subtruncata* qui est une espèce caractéristique constante et principale (BAKALEM *et al.*, 1990 a et b). L'estimation de la production et de la productivité de *Spisula* constitue un moyen d'évaluation de l'importance de ce bivalve vis à vis de la structure et du fonctionnement de l'écosystème auquel se rattache *Spisula subtruncata*

L'objet de la présente étude est d'estimer la production et la productivité de la population de*Spisula subtruncata* en différents points des sables fins de la baie d'Alger et cela en fonction du temps. Les méthodes d'estimation de la production diffèrent selon les auteurs, nos calculs de production ont été effectués en ayant recours à trois méthodes couramment utilisées: la méthode de la somme des pertes, la méthode dérivée de la courbe d'Allen (ou méthode de Crisp) et la méthode des cohortes moyennes.

Matériel et Méthode. La population de *S. subtruncata* a été échantillonnée à quatre stations (st.) (-10m) ; ces st. (1, 2, 3 et 4) couvrent l'ensemble des sables fins de la baie d'Alger. L'échantillonnage, mensuel de novembre 1984 à octobre 1985 (1er cycle) puis trimestriel de décembre 1985 à septembre 1986 (2e cycle), a été réalisé avec une benne Van-Veen. Chaque échantillon, soit 1 m2 de surface prélevée, est tamisée sur une maille de 1 mm. Le calcul du poids moyen des individus est obtenu grâce à la relation taille-poids établie pour *Spisula subtruncata* par BAKALEM (1979). La séparation des différentes cohortes constitutant la population de *Spisula* a été possible grâce au logiciel "Normsep" (GROS et COCHARD, 1978). La production somatique a été évaluée selon trois méthodes: méthode des cohortes moyennes, méthode de la somme des pertes et méthode de Crisp. Certains auteurs ont, enparticulier AMBROGI et OCCHIPINTI-AMBROGI (1987), BACHELET (1982), CORNET (1986) ont utilisé ces méthodes pour le calcul de la production chez les Mollusques Bivalves. Trois autres paramètres ont été calculés: la production somatique annuelle (Pg), la biomasse moyenne annuelle (B) et la productivité ou taux de renouvellement de la biomasse (Pg/B).

Résultats. Les méthodes de CRISP et la somme des pertes durant toute la période d'étude et à toutes les st. donnent des résultats similaires. Les valeurs de la biomasse relevées aux quatre st. sont : très élevées à la st. 2 (valeurs maximales): 137,21 g/m2 pour la biomasse soit une biomasse moyenne annuelle de 6,23 g/m2; moyennes aux st. 1 et 3, respectivement 66,77 et 63,59 g /m2 pour la biomasse ce qui fait des biomasses moyennes annuelles de 3,03 et 2,89 g/m2 ; faibles à la st. 4 (valeur minimale): 2,09 g/m2 (biomasse) et 0,095 g/m2 (biomasse moyenne annuelle). Concernant les valeurs de la production, la st. 1 présente la plus forte valeur pour la production annuelle (30,23 g/m2) suivie de prés par la st. 2 (27,01 g/m2). A la st. 3 la production annuelle est de 21,99 g/m2 tandis qu'à la st. 4 elle est très faible (0,56 g/m2). Le rapport Pg/B présente des valeurs élevées aux st. 1 et 3 respectivement 9,96 et 7,60. La st. 2 a le rapport Pg/B le plus faible (4,33) ; ce rapport a une valeur moyenne (5,89) à la st. 4. Le calcul de la biomasse moyenne annuelle par la méthode des cohortes moyennes met en évidence des différences entre les deux cycles d'étude. Les plus fortes biomasses sont enregistrées lors du 2e cycle : 22,92 (st. 2) et 31,86 g/m2/an (st. 1). Tandis qu'au 1er cycle la biomasse atteint sa valeur maximale avec seulement 12,90 g/m2/an à la st. 2, les st. 1 et 3 ont respectivement 3,24 et 4,52 g/m2/an, et une faible valeur (0,18g/m2/an) à la st. 4. Pour le calcul de la production et du rapport Pg/B il faut prendre en considération la longévité de *S. subtruncata* , qui en baie d'Alger varie entre 1 et 2,5 ans : la majorité des individus de *S. subtruncata* ont une durée de vie ne dépassant pas 1 à 1 an et demi, rares sont les individus atteignant 2 ans et exceptionnels les individus ayant une longévité de 2,5 ans (BAKALEM, 1979). De ce fait pour le calcul de la production nous avons envisagé pour la durée de vie de *Spisula* deux éven-tualités : 1 an, 1 an et demi. Les résultats obtenus ainsi figurent dans le tableau ci-dessous :

Station	Longévité	1er cycle Pg	1er cycle Pg/B	2e cycle Pg	2e cycle Pg/B	1er et 2e cyle Pg	1er et 2e cyle Pg/B
1	1 an	11,04	3,48	59,94	3,46	11,27	3,47
	1,5 an	7,28	2,29	39,56	2,30	7,44	2,29
2	1 an	44,34	3,44	90,78	3,96	31,96	4,79
	1,5 an	29,27	2,27	59,91	2,61	21,09	3,16
3	1 an	9,19	3,90	275,38	8,64	37,63	8,32
	1,5 an	6,06	2,57	181,75	5,70	24,83	5,49

La production au cours du 2e cycle est bien supérieure à celle du 1er cycle. La production maximale à la st. 3 lors du 2e cycle, et à la st. 2 durant le 1er cycle.

A la st. 4 la production est négligeable pour le 1er cycle, elle devient notable durant le 2e cycle (7,16 g/m2) et le rapport Pg/B est de 4,54. Les valeurs des rapports Pg/B du 1er cycle des st. sont proches; ce rapport est élevé à la st. 3 et ayant des valeurs voisines aux stations 1, 2 et 4 lors du 2e cycle. Pour toute la période d'étude (1et et 2e cycle), la st. 3 a la plus forte production et un rapport Pg/B élevé ; elle est suivie de la st. 2 puis la st. 1. Pour une longévité de 1 an et demi de *Spisula* nous avons les mêmes observations et remarques que celles pour une longévité de 1 an avec cependant une diminution des écarts entre les rapports Pg/B des différentes st.

Discussion-Conclusion. Les deux méthodes: méthode de Crisp et méthode de la somme des pertes, utilisées pour le calcul de la production de *S. subtruncata* conduisent à des résultats similaires. La méthode des cohortes moyennes donne des résultats différents de ceux obtenus par les deux autres méthodes à la st. 1 pour la production et le rapport Pg/B, cependant les valeurs biomasse sont très proches (Tableau ci-dessous) :

Méthodes de calcul de production / Station	Cohortes moyennes Longévité 1 an	Cohortes moyennes Longévité 1,5 an	Crisp
1 B	3,24		3,03
1 Pg	11,27	7,44	30,23
1 Pg/B	3,47	2,29	9,96
2 B	6,67		6,23
2 Pg	31,96	21,09	27,01
2 Pg/B	4,79	3,16	4,33
3 B	4,52		2,89
3 Pg	37,63	24,83	21,99
3 Pg/B	8,32	5,49	7,6
4 B	-		0,09
4 Pg	-	-	0,56
4 Pg/B	-	-	5,89

B et Pg : g/m2/an

Pour les st. 2 et 3, les trois méthodes donnent des valeurs de production et des rapports Pg/b légèrement différents dans le cas d'une longévité de 1 an et demi. Par contre pour une durée de vie de 1 an les écarts entre les valeurs de productions sont plus grands et les valeurs du rapport Pg/B très voisines.

Les fortes valeurs de production et de Pg/B enregistrées à la st. 3 sont dues à la densité élevée, aux recrutements importants et à la dominance des jeunes individus dans la population, celà est aussi le cas de la st. 2. La forte production et le rapport Pg/B élevé notés à la st. 4 durant le 2e cycle sont dus à un grand recrutement de jeunes individus lors de ce cycles. La st. 4 a une biomasse et une production réduites dues aux faibles densités de *Spisula* à cette station, par contre la valeur élevée du rapport Pg/B confirme la forte présence de jeunes individus recrutés. La production de *S. subtruncata* est sujette à de grandes fluctuations d'une année sur l'autre et celà est très net entre les production du 1er et 2e cycle. La population de *S. subtruncata* en baie d'Alger a une production légèrement supérieure à celle de *Spisula* étudiée par AMBROGI et OCCHIPINTI-AMBROGI (1987) au niveau du Delta du Po sur les fonds de -8m. Ces auteurs notent une valeur de production maximale de 31,91 g/m2/an en 1980. Cependant les valeurs des années 1979 à 1983 (0,87 à 16,94 g/m2/an) sont inférieures aux nôtres. Les valeurs de production sur les fonds de - 5m données par ces auteurs sont légèrement supérieures en 1980 et 1981, et inférieures les autres années (1979, 1982 et 1983) à nos valeurs. Par contre nos valeurs de production selon la méthode des cohortes moyennes sont sauf pour 1981, plus élevés chez la population *S. sub-truncata* de la Baie d'Alger. Ces valeurs élevées sont le signe d'une fréquence importante du "turnover" de la matière organique que cette espèce présente au niveau des sables fins de la baie. Les fortes valeurs de la biomasse et la production de *S. subtruncata* en baie d'Alger confirmerait un gradient de la production Nord-Sud, c'est-à-dire que la biomasse et la production sont généralement plus élevées dans la partie Sud que dans la partie Nord de la Méditerranée.

Production de la population de *Venus Gallina* (L) (Mollusque Bivalve) en baie d'Alger

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A l'échelle de la Méditerranée le mollusque bivalve *Venus gallina* est considéré comme une espèce pilote des peuplements de sables fins des petits fonds côtiers. *V. gallina* est une espèce caractéristique constante et principale du peuplement des sables fins de la baie d'Alger (BAKALEM, 1979). L'importance de *V. gallina* au sein du peuplement des sables fins en temps que producteur secondaire de matière organique est de premier ordre. L'estimation de la production et de la productivité permet d'apprécier le rôle de cette espèce au sein de la structure, et dans le fonctionnement, du peuplement auquel elle se rattache. C'est là le but de notre présente étude sur la population de *V. gallina* en baie d'Alger. Dans cette baie *V. gallina* a une reproduction étalée sur toute l'année et de ce fait un recrutement des jeunes individus étalé dans le temps (BAKALEM, 1981). Ainsi celà rend la séparation des différentes cohortes constituant la population de *Venus* difficile et délicate. Cette séparation des cohores est indispensable pour le calcul de la production avec certaines méthodes telles que les méthodes de Crisp et la somme des pertes. La méthode des cohortes moyennes mise au point par HYNES (HYNES, COLEMAN, 1968) ne nécessite pas une séparation des cohortes. Cette méthode répond bien à notre cas qui est le calcul de la production de *V. gallina* où la décomposition de la population en classes d'âge est difficile.

Matériel et méthodes. Les échantillons de *V. gallina* proviennent de quatre st. (1, 2, 3 et 4) de sables fins (-10m) de la baie d'Alger. Les prélèvements ont été effectués au moyen d'une benne Van-Veen sur une surface de 1 m^2 pour chaque st. et tamisés sur une maille de 1 mm. L'échantillonnage est mensuel de novembre 1984 à octobre 1985 (1er cycle), puis trimestriel de décembre 1985 à septembre 1986 (2e cycle). La relation taille-poids établie par BAKALEM (1979) pour *V. gallina* a permis de calculer le poids moyen (en poids sec) des individus. La production somatique (Pg) a été évaluée selon la méthode des cohortes moyennes, méthode déjà utilisée par CORNET (1986) pour le calcul de la production d'*Abra alba*. La biomasse moyenne (B), la productivité ou taux de renouvellement de la biomasse (Pg/B) sont également calculés. Les paramètres : Pg, B et Pg/B ont été déterminés pour *V. gallina* à chaque cycle, et pour toute la période d'étude (novembre 1984 à septembre 1986).

Résultats. Le calcul de la production par la méthode des cohortes moyennes tient compte de la longévité de l'espèce. L'estimation de la longévité est généralement difficile et délicate. La longévité de *V. gallina* est de 2 ans sur les côtes de Provence (MASSE, 1971) 2 à 3 ans dans le golfe de Marseille (BODOY, 1983) 2, 5 à 3 ans en baie d'Alger (BAKALEM, 1981). Dans notre travail pour le calcul de la production trois éventualités concernant la durée de vie de *V. gallina* ont été retenues : 2, 2,5 et 3 ans. Les résultats ainsi obtenus figurent dans le tableau ci-dessous.

Les valeurs de la biomasse fluctuent lors du 1er cycle entre 5,46 (st. 1) et 21,89 g/m^2/an (st. 4). Les st. 2 et 3 ont des biomasses très proches. Pour le 2e cycle les biomasses sont comprises entre 2,03 (st. 2) et 4,10 g/m2/an (st. 1).

Les st. 2, 3 et 4 ont des valeurs de biomasse voisines, le calcul de la biomasse en cumulant le 1er et 2e cycle donne des valeurs variant entre 2,75 (st. 1) et 8,68 g/m^2/an (st. 4), les st. 2 et 3 présentent des biomasses presque identiques. Pour une longévité de *V. gallina* de 2 ans la production somatique notée aux différentes st. lors du 1er cycle présente des valeurs élevées : production maximale (36,85 g/m^2/an) à la st. 4, et production minimale (9,50 g/m^2/an) à la st. 1. Les st. 2 et 3 ont des valeurs de production proches. La production diminue considérablement du premier au second cycle où elle est comprise entre 4,38 (st. 3) et 1,91 g/m^2/an (st. 1). L'examen des rapports Pg/B montrent qu'au cours du 1er cycle ils ont des valeurs voisines: 1,65 (st. 3) à 1,89 (st. 2).

Par contre au cours du 2e cycle les valeurs de ce rapport diminuent, sauf à la st. 2 où la valeur augmente très légèrement; cette diminution est surtout forte à la st. 1 où Pg/B passe de 1,73 à 0,46.

	Station	Biomasse moyenne(B)	Longevité 2 ans Pg	Pg/B	2,5 ans Pg	Pg/B	3 ans Pg	Pg/B
1er cycle	1	5,46	9,50	1,73	7,60	1,39	6,27	1,14
	2	9,65	18,26	1,89	14,61	1,51	12,05	1,24
	3	10,79	17,84	1,65	14,27	1,32	11,77	1,09
	4	21,89	36,85	1,68	29,48	1,34	24,32	1,11
2e cycle	1	4,10	1,91	0,46	1,52	0,37	1,26	0,30
	2	2,03	3,95	1,94	3,16	1,55	2,60	1,28
	3	2,72	4,38	1,60	3,50	1,29	2,89	1,06
	4	2,41	3,10	1,28	2,48	1,03	2,05	0,85
1er + 2e cycle	1	2,75	5,06	1,84	4,04	1,47	3,34	1,21
	2	4,10	7,92	1,93	6,34	1,54	5,23	1,27
	3	4,65	7,77	1,66	6,21	1,33	5,12	1,10
	4	8,68	16,36	1,88	13,08	1,50	10,79	1,24

B et Pg : g/m^2/an

En cumulant le 1er et 2e cycle les valeurs de production sont moyennes, de 5,06 (st. 1) à 16,36 g/m2/an (st. 4). Comme lors du 1er et 2e cycle les st. 2 et 3 ont des valeurs de production très voisines. Les valeurs du rapport Pg/B ne sont pas très différentes d'une st. à une autre (comprise entre 1,66 et 1,93). Pour des longévités 2,5 et 3 ans de *V. gallina* les valeurs de production et du rapport Pg/B dans leur ensemble diminuent. Mise à part ces diminutions toutes les observations et remarques concernant la production et le rapport Pg/B de *V. gallina* avec une longévité de 2 ans restent valables pour des longévités de 2,5 et 3 ans.

La production moyenne de la population de *V. gallina* est comprise entre 5,06 (st. 1) et 16,36 g/m^2/an (st. 4); aux st. 2 et 3 cette production est presque identique.

La productivité moyenne présente des valeurs élevées et presque similaires (1,66 à 1,93) aux 4 st.

Discussion-conclusion. Les biomasses aux 4 st. durant le 1er cycle sont bien supérieures à celles du 2e cycle. La st. 4 présente la biomasse maximale (21,89 g/m^2/an) notée pour *V. gallina* en baie d'Alger. La st. 3 par ses biomasses se classe toujours en seconde position, après la st. 4 durant le 1er cycle, et derrière la st. 1 lors du 2e cycle. Les st. 2 et 3 ont durant l'étude des biomasses proches. Les fortes biomasses enregistrées sont liées aux densités élevées en *V.* des st. Les valeurs de la production à toutes les st. durant le 2e cycle sont extrêmement faibles comparativement à celles du 1er cycle. La production maximale (36,85 g/m^2/an) se situe à la st. 4 lors du 1er cycle tandis que pour le 2e cycle la plus forte valeur est de 4,38 g/m^2/an à la st. 3, st. proche de la st. 2 par sa valeur de production. Les rapports Pg/B ont aux différentes st. aussi bien lors du 1er cycle que du 2e cycle des valeurs proches. La forte à la st. 1, et faible aux st. 3 et 4, diminution du rapport Pg/B du 1er cycle au 2e cycle est liée à la densité et à la structure de la population de *Venus* à ces st. Lors du 1er cycle la population de *V.* aux quatre st. est en grande majorité constituée d'individus de taille comprise entre 20 et 30 à croissance pondérale importante, le pourcentage des individus de taille inférieure à 20 mm et de jeunes (1 à 10 mm) fraîchement recrutés est faible. Une telle structure de la population est à l'origine de valeurs élevées de la production et du rapport Pg/B. Durant le 2e cycle, la structure de la population de *Venus* est tout à fait inverse à celle du 1er cycle aux st. 1, 3 et 4; de ce fait la production et le rapport Pg/B en cette période sont faibles. La légère augmentation du rapport Pg/B à la st. 2 observée au cours du 2e cycle a comme origine des recrutements importants et un nombre élevé d'individus de taille comprise entre 20 et 30 mm. La production et le rapport Pg/B de *V. gallina* diminuent en fonction de la longévité. Plus la durée de vie augmente, plus les écarts entre les Pg/B des 4 st. diminuent. Les biomasses de *V. gallina* en baie d'Alger sont supérieures à celles des côtes de Provence (France) (MASSE, 1971). La production maximale observée par MASSE (1971) dans le Golfe de Fos pour *V. gallina* sur des fonds de -5m est de l'ordre de 20 g/m2/an. La biomasse moyenne (1,50 g/m2) et la production (0,61 g/m2/an) de *V. striatula* sur les côtes du Pays de Galles (WARWICK *et al.*, 1978) sont bien moins élevées que les résultats que nous avons obtenus pour *V. gallina* en baie d'Alger. Le rapport Pg/B=0,41 trouvé par WARWICK *et al.* (1978) est nettement inférieur à celui de la baie d'Alger. Ces comparaisons de la production et de la productivité des populations de *V. gallina* en baie d'Alger et en d'autres points de son aire géographique de distribution mettent bien en évidence pour *V. gallina* que les valeurs de production et du rapport Pg/B sont dans la partie Sud, bien supérieures à celles de la partie Nord de son aire de répartition.

Particularités écologiques du développement de la végétation algale macrophyte de la Côte Roumaine de la Mer Noire

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Le développement de la végétation algale macrophyte sur la côte roumaine de la Mer Noire est le résultat de l'action de certains facteurs écologiques labiles.

La péridiocité de développement des algues macrophytes et leur migration saisonnière de la surface vers les profondeurs est conditionnée par une série de facteurs hydro-météréologiques parmi lesquels la température (de l'eau, de l'air) et le régime de la lumière dans les eaux du littoral ont le rôle le plus important.(1)

Ce développement présente sur la côte roumaine quelques particularités bien distinctes.

1. Au printemps, à partir de la deuxième moitié du mois de mars jusqu'au début du mois de juin, on assiste à l'apparition d'une diversité qualitative prononcée. A côté des formes d'eau froide (*Porphyra, Bangia, Urospora, Scytosiphon*, etc.) apparaissent de nombreuses espèces d'eau plus chaude, (*Ulva, Polysiphonia, Striaria, Punctaria*, etc.). On explique cette chose par l'inversion des valeurs thermiques de la couche superficielle d'eau par rapport à celle profonde, valeurs qui augmentent d'environ 10°C. Une situation pareille mais, d'une fréquence plus réduite est recontrée aussi en automne (octobre-novembre).

2. La deuxième particularité est contraire à la première.

Evidemment, la diversité systèmatique baisse, mais au contraire quelques ces genres réussissent à produire une biomasse de valeur élevée. On rencontre cet aspect en été, de juin à septembre. La température de l'eau s'accroît beaucoup en dépassant, aux profondeurs de 2-3 mètres, 20-25°C. Les espèces d'eau froide disparaissent complétement. Au contraire des valeurs élevées des biomasses sont réalisées par les espèces: *Enteromorpha linza* (L.) J. Ag., *E. flexuosa*, (Wulf.ex Roth.) J. Ag., *E. intestinalis* (L.) Link., *Cladophora vagabunda* (L.) Hoek, *Cl. sericea* (Huds.) Kütz, *Cl. laetevirens* (Dillw.) Kütz., etc. On ajoute à celles-ci d'autres espèces du genre Ceramium: *C. rubrum* (Huds). C. Ag., *C. elegans* (Roth.) Ducl., *C. arborescens* J. Ag., etc., surtout pendant la deuxième moitié de l'été et au début d'automne.(2)

3. La troisième particularité concerne l'existence des espèces d'algues macrophytes qui peuvent présenter des interruptions de leur cycle, pouvant même disparaître pour une période de temps. C'est le cas de *Striaria attenuata* (Grev.) Grev., *Punctaria tenuissima* (Ag.) Grev. qui ont refait leur apparition sur nos côtes après une "éclipse" de 10-15 ans ou bien la disparition depuis 15-20 ans de l'espèce *Dasya baillouviana* (Gmel.) Mont. qui n'a pas encore fait sa réapparition. On peut expliquer les particularités mentionnées plus haut par les conditions écologiques changeantes du printemps et de l'automne et par les conditions écologiques uniformes de l'été et de l'hiver, saisons pendant lesquelles ne peuvent se développer que certaines formes, bien adaptées à de telles conditions spécifiques. Durant ces deux dernières saisons on rencontre des valeurs extrêmes de la température (hiver-été). En hiver, les eaux du littoral arrivent à la fin du mois de janvier et au mois de février à stratification thermique ayant la plus basse de 3,1°C avec une croissance légère de la surface vers la profondeur. C'est aussi la période quand les eaux du littoral peuvent geler pendant les hivers extrêmement froids (par exemple les années : 1972, 1976, 1984, 1985). La concentration réduite de sels de nos eaux côtières (environ 15-16gS‰) fait que le point de gelée de l'eau soit d'environ -0,7°C jusqu'à -1°C. Les effets de la glace sur la flore algale sont desatreux.(3).

Voilà pourquoi pendant ces deux saisons (en été et en hiver) peuvent se développer des formes vraiment saisonnières - qui ont une amplitude d'adaptation relativement réduite. C'est le cas de l'apparition de l'espèce *Dasya baillouviana* (Gmel.) Mont. au mois d'août, des espèces comme: *Chaetomorpha aerea* (Ag.) Kütz., *Ch. crassa* (O.F. Müll.) Kütz., ou *Chondria tenuissima* (Good. et Wood.) Ag. pendant la saison estivale ou des espèces des genres *Urospora, Bangia, Porophyra, Scytosiphon*, etc., durant la saison froide, comme je l'ai déjà mentionné.

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B

B

Chromatographic analysis on sponges with autotrophic symbionts

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Many sponges contain large populations of symbiotic microorganisms both autotrophic (cyanobacteria, zooxanthellae and zoochlorellae) and heterotrophic (bacteria). According to WILKINSON (1987) about 40 % of Caribbean and Great Barrier Reef sponges are involved in autotrophic relations. The cyanobacterial symbiosis is widely diffused in the tropical and temperate areas (SARA', 1966; WILKINSON, 1987), while zooxantellae have been exclusively observed in several species of the genus *Cliona* (SARA' and LIACI, 1964; PANG, 1973). Finally zoochlorellae appear to be typical symbiotic elements of the green freshwater sponges (GILBERT and ALLEN, 1973; WILLIAMSON, 1979). These kinds of symbiosis have been studied mainly from morphological and ultrastructural aspects, while less quantitative data on pigments concentrations are generally available (GILBERT and ALLEN, 1973; WILKINSON, 1983). Utilizing the HPLC (MANTOURA, 1983; HECQ *et al.*, 1992), it is possible to obtain a quantitative analysis of a large spectrum of pigments. This kind of analyses should clarify several aspects of these relationships : for example, seasonal changes in pigment composition and primary productivity or trophic aspects between the algal component and the host. These first chromatographic analyses concern the symbiocortex of two common Mediterranean species, *Petrosia ficiformis* and *Cliona viridis* which show a symbiotic relationship with cyanobacteria *(Aphanocapsa feldmanni)* and zooxantellae, respectively (SARA', 1966). The samples have been collected along the Portofino Promontory cliff (Ligurian Sea) at about 20 m depth, during November 1991. In the Tab. 1 the quantitative data ($\mu g/cm^2$) are reported. The quantitative and qualitative differences between the pigment spectra are related to the different kind of symbionts and to possible contamination caused by epibiotic algae. A high percentage of Chl-a is noted in both the species, but only *Cliona* presents a large quantity of Chl-c and peridinine, typical zooxanthellae pigments. It is particularly interesting to note the complete absence of phaeophitines and phaephorbides, confirming the absence of ingestion of the alga by the host (WILKINSON, 1978).

Tab. 1. Pigment quantity ($\mu g/cm^2$) in two Mediterranean sponges

	Petrosia ficiformis	*Cliona viridis*
Total Chl-a	12.02	8.61
Chl-b	0	0.68
Chl-c3	0	0
Chl c1 + c2	0	1.26
Peridinine	0.06	2.60
Butanoyloxyfuco.	0	0.59
Fucoxanthin	0	0.59
Hexanoylfuco.	0.25	0.32
Zeaxanthin (?)	2.45	0.23
Diadinoxanthin	0	0.20
Diatoxanthin (?)	0.24	0
Alloxanthin	0	0.38
Total phaeophitines	0	0
Total pheophorbides	0	0
α carotenoids	0	0.12
β carotenoids	1.11	0.18

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Patch monitoring as a field method to quantify natural disturbance in hard bottom communities

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Natural disturbance is usually considered one of the most important structuring agents of both marine and terrestrial communities (SOUSA, 1984a). According to SOUSA (1984a) disturbance is defined as "...a discrete, punctuated killing, displacement or damaging of one or more individuals (or colonies) that directly or indirectly creates an opportunity for new individuals (or colonies) to become established".

In shallow benthic communities, wave action and predation are two of the most important factors displacing sessile organisms from the substratum. These physical and biological processes may produce patches of bare space or of encrusting species (which are more resistent to dislodgement than erect organisms) within a given assemblage. The number and size distribution of such patches, generally monitored through time in fixed plots, have been used to quantify natural disturbance in intertidal communities (PAINE and LEVIN, 1981; FARRELL, 1989).

The method adopted to estimate the size of each single gap, was to measure the two principal axes of an elliptical or rectangular approximation to a patch (PAINE and LEVIN, 1981). However, no attempts have been made to verify how good these approximations are, and if the relationships between the measured and the true values vary with patch size and complexity.

Here we present the results of a correlative analysis comparing precise and approximated values of the perimeters and areas of 25 patches of encrusting corallines in *Cystoseira*-dominated littoral pools on the west coast of Italy (Ligurian Sea).

The two principal axes of each patch were measured in the field by treating them as rectangles or squares. Very irregulary shaped gaps were decomposed in subpatches, more easely amenable as regular geometric figures. Approximate estimates of perimeters and areas were obtained by adding (and doubling) or multipling the two major axes of each gap, respectively. The contour of each patch was also traced on a plexiglass sheet in the field and then on a drawing paper in the laboratory. Precise estimates of perimeters (± 0.5cm) were obtained by tracing again the contour of the drawings with a map measurer. Precise estimates of areas were obtained as follows: first the field maps were cut off from the drawing papers and weighed (± 0.001gr). Then the weight values were converted in areas using the equation obtained from the linear regression of paper size versus weight. This function was previously calculated by weighing squares of known size cut off from the same type of papers of those used to trace the patches.

The relationships between approximated and precise estimates of perimeters and areas are presented in Fig. 1. Both the correlation coefficients are highly significant, indicating that the field method usually adopted to estimate patch size and perimeter is a good approximation of the true values (at least for the range of sizes considered in this study).

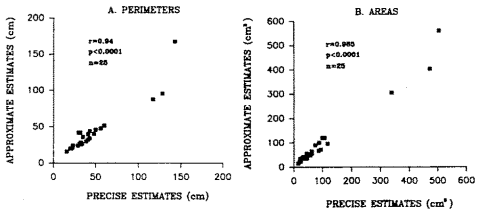

Fig. 1. Relationships between precise and approximate estimates of patch perimeters (A) and areas (B).

Knowledge of the disturbance rate to which a given assemblage is subjected may greatly improve our understanding of community structure and dynamics in hard bottom environments. The patterns of community recovery after damage are a product of the life histories of the species available to colonize a disturbed site and the severity and frequency of the disturbing force (SOUSA, 1984a). Factors such as gap size and shape, time of gap formation and the heterogeneity of its internal environment, may all affect the recolonization of a given patch and contribute to the spatial and temporal variability of species distribution (SOUSA, 1984a, 1984b; FARRELL, 1989). Most of these parameters (e.g. patch size, perimeter and shape, which is expressed as the ratio of the major axis on the minor one) are easely calculated once the two principal axes of a given patch are known.

Thus patch monitoring is a precise, inexpensive (although time consuming) and simple method to quantify the impact of disruptive forces on marine hard bottom assemblages. Moreover this information can be used to plan field experiments where artificially cleared patches of different size and shape (spanning the range of naturally formed gaps), are produced to test for the effects of these variables on patterns of patch recovery. Such kind of experiments are already in progress in *Cystoseira*-dominated littoral pools on the west coast of Italy.

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Sur la présence de *Neocnus incubans* (Echinoderme-Holothurie incubatrice) dans l'Algérois

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Décrit par CHERBONNIER (1972), *Neocnus incubans* (Holothurioidea-Cucumariidae) a été récolté pour la première fois en 1969, par MM. ZIBROWIUS et BOUDOURESQUE à l'Ouest de Bizerte (Tunisie). La description de ce genre et de son espèce type ainsi définis par CHERBONNIER : "Holothurie dendrochirote de très petite taille, à dix tentacules dont deux ventraux plus petits ; couronne calcaire simple, sans prolongements caudaux ; podia disposés en un seul rang sur chaque radius ventral ; pas de podia sur les radius et interradius dorsaux ; incubent leurs oeufs dans un marsupium dorsal".

Au début de l'année 1990, nous l'avons récolté dans plusieurs localités de la côte algérienne. C'est ainsi sa première découverte en Algérie et sa deuxième signalisation, après la Tunisie, au niveau de la côte méditerraneenne de l'Afrique. En dehors de ces deux localités, cette espèce a été signalée aux Iles Canaries et au large de Gérone en Espagne (ALVA,1991).

Sur le plan descriptif, et en comparaison avec les individus de la côte tunisienne (CHERBONNIER, 1972), nos échantillons présentent certains détails au niveau de la taille et des podia :

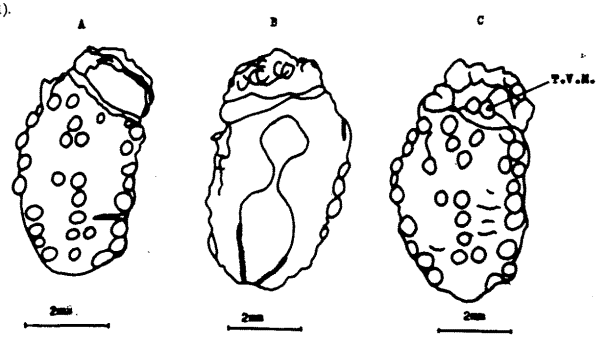
- Nous avons eu des individus ayant une taille maximale de 7 mm de long, alors qu'elle est de 6 mm chez les individus tunisiens.
- Un des radius ventraux ne montre pas d'une façon très nette, des podia disposés en un seul rang (voir dessin).
- Le nombre maximum des podia par rang est de 7 à 8 chez les individus tunisiens, alors qu'il est de 10 à 12 en Algérie. Selon la taille des individus, nous avons compté généralement:
  + 7 à 8 podia chez les individus de 3 mm de long.
  + 10 à 12 podia chez les individus dont la taille est égale ou supérieure à 5mm.

Ces détails ont pu être observés grâce au nombre important d'individus récoltés (on compte parfois plus de 900 individus par 400 cm). De telles "différences" sont dues soit à la taille, soit à l'âge et peut-être aussi au milieu.

Sur le plan écologique, cette espèce est connue jusqu'à présent dans trois peuplements de la Biocénose des algues photophiles. De tels peuplements sont installés dans le premier mètre de la surface. Les localités sont :

- En Tunisie : elle a été trouvée à l'Ouest de Bizerte dans le peuplement de *Cystoseira sedoides* , algue brune endémique de la Méditerranée (Afrique du Nord et Ile Pantelleria).
- En Algérie : nous l'avons récoltée sur les platiers dans différents endroits :
  + Au Complexe d'El Kettani (situé juste à l'Ouest du port d'Alger) dans le peuplement de Corallines.
  + A Ain Benian (situé à 20 km à l'Ouest d'Alger) dans le peuplement de Corallines.
  + A Boumerdès (situé à 40 km à l'Est d'Alger) dans le peuplement de Corallines et dans les moulières recouvertes de touffes de Corallines.
- En Espagne (Gérone, et Iles Canaries), elle est rencontrée dans les Cystoseires (ALVA,1991).

Sur le plan biogéographique et en se basant sur les études antérieures des peuplements des algues photophiles aussi bien en Méditerranée qu'en Atlantique, nous constatons qu'en plus de notre nouvelle signalisation de *Neocnus incubans* en Algérie, il est trouvé jusqu'à présent dans deux localités de la Méditerranée : Tunisie (CHERBONNIER, 1972) et en Espagne (ALVA, 1991). En dehors de la Méditerranée, il est rencontré aux Iles Canaries (PEREZ-RUZAFA *et al.*,1984 ; BACALLADO J.J. *et al.*,1985 ; PEREZ-RUZAFA *et al.*,1988 *in* ALVA, 1991).



Neocnus incubans

- A et B : même individu de 5,5 mm de long (A: vue ventrale montrant les podia; le rang médian ne présente pas vraiment un rang unique de podia. B : vue dorsale montrant le marsupium quasiment ouvert).
- C : individu de 6,5 mm de long, montrant les deux tentacules minuscules ventro-médians (T.V.M.).

Remerciements

Je remercie le Professeur CHERBONNIER de m'avoir confirmé l'identification de l'espèce.

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Sublittoral benthic fauna and flora around a volcanic island, Milos Island, Aegean Sea, Greece

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Four samplings concerning macrozoobenthos and phytobenthos took place at four different points north, east and south of the island of Milos, by the coast at depths ranging from 0 to 16 meters (Fig. 1).

The samples were taken for the purpose of assessing any possible environmental effects from the disposal of brine of an experimental geothermal power station located at the center of the island.

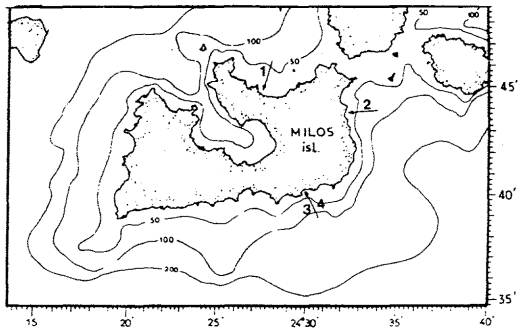
The general project was funded from the Public Power Corporation (PPC).

Zoobenthos samples were taken with a Ponar grab (0.05 sq.m) operated from a fishing vessel 15 meters long. Phytobenthos samples were taken by scuba diving using a frame of an area of 400 sq.cm.

The brine was disposed, irregularly for a short period of time, through an outfall system at the southern coast (stations 3 and 4). The other stations (stations 1 and 2) were considered as reference ones.

The analyses of the samples gave a total of 125 zoobenthos species and 119 phytobenthos species. The substrate at stations 1, 3, 4 was sandy while that of station 2 much coarser (small cobles). This is attributed to the fact that the near abrupt coast is intensivelly mined, providing thus the coarser material which covers the bottom of the nearby coast.

Fig. 1. Map of Milos Island with the sampling stations



From the zoobenthic point of view, station 2 is also characterized by the highest values of diversity and aboundance at all the seasonal samples. The coarse sediment promotes the formation of microhabitats between the wider spaces of the grains allowing thus the easier water circulation deeper in the sediment carrying food and oxygen to the endofauna (SANDERS 1958). On the contrary at the same station phytobenthos has the lowest values of diversity and abundance in relation to the other stations, because of the increased turbidity in the area from the active mining near the coast.

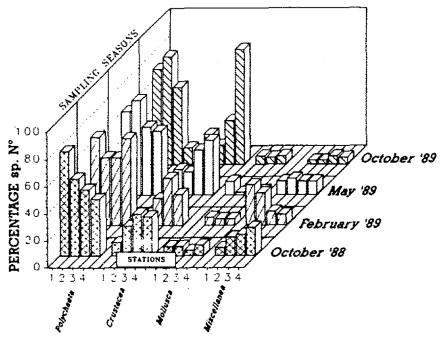


Fig. 2. Seasonal distribution of various zoobenthos taxa per station.

The fauna at the stations 1, 3, 4 is characteristic of the sandy islands between expanded meadows of *Posidonia oceanica*. At station 4, but only in a sample from the first sampling, the zoobenthos community seems degraded. The presence of *Capitella capitata*, an oxygen deficiency indicator (BELLAN & BELLAN-SANTINI, 1972) is characteristic for that sample. The color of the sediment in this sample was dark and the hydrogen sulphide odor was strong but its presence is attributed to the volcanic character of the island and has nothing to do with rotting organic material like in domestic effluent discharges. On the other hand the nearby coast is partly yellow probably from the oxidation of volcanic hydrogen sulphide to pure sulphur flowers. At the same stations the phytobenthos is rich enough in number of species and coverage in comparison with the samples collected at station 2.

The presence of expanded meadows of *Posidonia oceanica* in relation with the normal zoobenthos distribution (Fig. 2) indicates a healthy marine environment, even at the stations 3 and 4 where the brine was disposed.

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B

Analyse des modalités de la multiplication végétative et de la reproduction sexuée de *Posidonia oceanica* et de ses conséquences sur la constitution génétique des herbiers

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La phanérogame marine de Méditerranée, *Posidonia oceanica* (L.) Delile, couvre de vastes étendues au niveau de la zone infra-littorale jouant un rôle prédominant dans la chaîne alimentaire, la stabilité des fonds et la qualité des eaux. Cependant les herbiers de *P. oceanica* ont régressé ces vingt dernières années sur les côtes françaises car l'espèce est particulièrement menacée par l'ensemble des activités humaines. Les causes de cette régression sont recherchées dans les modalités de sa reproduction et la constitution génétique de ses peuplements.

La reproduction sexuée de *P. oceanica* rencontre de nombreux obstacles. Les floraisons sont soumises à des variations annuelles qui semblent climatiques (GIRAUD, 1977). Lorsque les années sont favorables, les floraisons se produisent seulement dans des zones restreintes, qui à l'observation au cours de plusieurs années, se sont révélées être toujours les mêmes, comme dans la baie de Villefranche (CAYE et MEINESZ, 1984), et en Corse aux îles des Lavezzi (MEINESZ *et al.*, 1988). De plus, au moment de la nouaison et pendant l'accroissement des jeunes fruits, survient souvent, une chute massive des inflorescences (CAYE et MEINESZ, 1984; PERGENT, 1985; ROMERO, 1989). A maturité, les fruits se détachent de la plante et peuvent flotter pendant plusieurs jours. Ils constituent l'organe de dissémination de la plante; le fruit est déhiscent et la graine se détache tombant sur le fond. Mais en fonction des courants, les fruits sont le plus souvent échoués sur les plages ou entraînés au-delà de la limite inférieure des herbiers et la production de graines peut être perdue en partie ou en totalité. La germination est immédiate (sans diapause ni dormance, la plantule doit aussitôt se fixer pour se développer, elle ne peut le faire que si elle est immobilisée sur un substrat favorable, le plus souvent un herbier. Si la plantule parvient à se fixer, elle se développe donnant naissance à un nouvel individu qui se juxtapose aux autres individus plus âgés de l'herbier. Ainsi, toutes les étapes de la reproduction sexuée de *P. oceanica* montrent des obstacles successifs qui la rendent relativement rare sur les côtes françaises de Méditerranée.

La multiplication végétative de *P. oceanica* se produit surtout par multiplication et accroissement de ses axes. Chez cette espèce, le développement est particulièrement lent, avec un allongement de 1cm/an des axes orthotropes (PICARD, 1953; CAYE, 1980), de 3.5cm à 7.5cm des axes plagiotropes et l'apparition de moins d'une à 6 ramifications par an selon les axes (MEINESZ et LEFEVRE, 1984; CAYE, 1980). Au moment des tempêtes, des fragments de rhizomes peuvent être arrachés et jouer le rôle de bouture. Ce mode de multiplication paraît cependant assez peu fréquent (4 boutures/ha/an : MEINESZ et LEFEVRE, 1984). En effet, la fixation et la survie des boutures exigent plusieurs conditions favorables concernant le type d'axe (orthotrope ou plagiotrope), la dimension des rhizomes, la saison (MEINESZ *et al.*, 1992). La mortalité est particulièrement importante pour les boutures arrachées à faible profondeur et entraînées plus profondemment (MOLENAAR et MEINESZ, 1992). Par accroissement des axes plagiotropes, un individu se développe horizontalement sur le fond donnant naissance à un clone; la poussée verticale particulièrement lente permet aux peuplements de se maintenir en place en harmonie avec la sédimentation (BOUDOURESQUE et JEUDY de GRISSAC, 1983). Il existe parfois une continuité entre les rhizomes de surface et ceux qui sont situés à la base de la matte de l'herbier (PICARD, 1953); des rhizomes situés à la base de certaines mattes ont été datés au C14 et témoigne d'une ancienneté de plus de 1000 ans (BOUDOURESQUE *et al.*, 1980). Dans ces conditions, il paraît possible que certaines parties de l'herbier soient constituées de clones très anciens provenant de la germination d'une graine il y a plusieurs siècles. Quant à la multiplication par boutures, lorsqu'elle survient, elle ne fait qu'assurer la propagation d'un clone déjà existant et plus ou moins ancien.

L'action conjuguée d'un développement végétatif sur une plante pérenne comme *P. oceanica*, et d'une reproduction sexuée que l'on pourrait qualifiée d'accidentelle entraîne la constitution de peuplements formés d'une mosaïque d'individus ou clones plus ou moins étendus selon leur ancienneté. La limite de ces clones n'est pas visible normalement dans un herbier en raison de l'aspect monomorphique de cette espèce. Cependant, les zones présentant des floraisons au sein d'herbiers purement végétatifs pourraient correspondre à des clones ayant la propriété de pouvoir fleurir. Il est très difficile, dans l'état actuel de nos connaissances, de comprendre pourquoi en un même lieu, seuls de rares individus seraient capables de fleurir dans un peuplement. Néanmoins, chez une monocotylédone ligneuse comme *P. oceanica*, il est possible que la période de floraison d'un individu soit limitée dans le temps, apparaissant notamment après une période juvénile plus ou moins longue.

De plus, la reproduction sexuée qui survient à l'intérieur d'un clone unique, conduit à une autofécondation même si la fleur présente une structure florale favorisant l'allogamie comme c'est le cas chez *P. oceanica*. Le manque de vigueur qui se manifeste particulièrement dans la lenteur du développement végétatif est en partie responsable du recul de l'espèce qui ne parvient pas rapidement à reconquérir les espaces détruits. Les faibles performances de croissance et de développement de *P. oceanica* sont-elles dues à un vieillissement des clones ou à l'effet de l'autofécondation à l'intérieur des clones ? Seule une étude sur la variabilité génétique des peuplements pourrait répondre à cette question.

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Natural and artificial settlements of red coral, *Corallium rubrum* (L.): preliminary observations

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Although the laboratory-rearing of Coelenterates has been particulary successful, several problems connected to larval cycle and development of early stages still arise for the red coral *Corallium rubrum* (STILLER & RIVOIRE, 1983).

A research program between the Istituto di Zootecnica of the University of Sassari and the Centre Scientifique de Monaco investigated the following points :

- rearing of larvae of *Corallium rubrum* in aquarium;
- morphological and anatomical studies on their development.

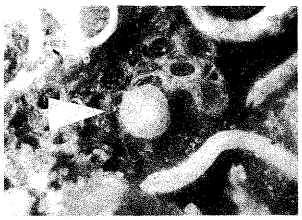
A first lot of larval stages, obtained from colonies caught offshore from Marseilles, were kept in open-circuit tanks where sea-water from a depth of 50 m arrived directly and without any filtration or sterilization. Light of 12.9 uE m-2 s-1 (12 hour/light, 12 hour/dark) was supplied. In addition to nutritional particles found in the sea-water, the larvae were fed with mussel juice twice a week.

Other larval stages, obtained from both deep (-100 m) and shallow (-15 m) colonies of a submarine cave, were kept in closedcircuit aquaria at atmospheric pressure, at a constant temperature (15°C), constant salinity (37%), and constant pH (about 8.2) at Sassari University. The dissolved oxygen was always above saturation point. A double filtration system (mechanical and biological) and a UV lamp were used. Light was supplied by a blue lamp 18 W: a timer simulated the seasonal variations. Young settled stages were fed with mussel juice and valine twice a week.

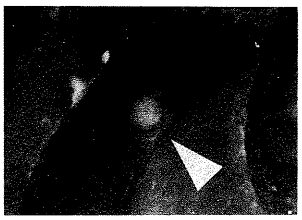
In this way two different types of aquarium conditions were tested. The emission of larvae was obtained in the aquaria in Monaco half way through June 1991 and one month later in Sardinia using thermic and osmotic shocks as well as by spontaneous liberation. The larval behaviour observed was very similar to that described by LACAZE-DUTHIERS (1864).

In consideration of the importance that bacterial and diatom films have on the settlement surface (LOYA, 1976), different types of hard substrata enriched by them were tested in Monaco. The preference scale was as follows: remains of coralligenous on the base of *Corallium rubrum*(60%), coralligenous only (30%), clay tile (6%), rough plexiglass surface (3%), glass (1%). The subsequent experiments showed that the planulae settle 10 days after birth. Two days later some sclerites were distinguishable: at first they appeared white but three days later became pink. Their pigmentation reached its maximum one week after settlement, when a second polyp appeared.

In Sardinia only coralligenous substrata and dead corals were used (i.e. *Corallium rubrum*, Madreporaria, etc.) as settlement surfaces where most of planulae settled during August. These findings are slightly different from those obtained in Monaco as well as those obtained by other Authors who observed settlements after 1-2 weeks (LACAZE-DUTHIERS, cit.; VIGHI, 1970). Six months later, at Sassari University, almost 20% of young stages were still alive, and we couldn't find any of them which bore more than two polyps.



Early *Corallium rubrum* settlement (two months old)



A two polyp stage of *C. rubrum* (three and a half months old)

These observations confirm the data reported by VIGHI (cit.). Conversely they don't correspond with the findings of GIACOMELLI *et al.* (1988) who said they had obtained colonies bearing about 50 polyps, 1 cm high, within a year!

The 20% of young stages from shallow colonies that we measured had a base diameter of about 0.8-1 mm, but the height of most of them was incalculable. On the other hand, after eight months from the fixation of larvae, young stages obtained in Monaco appeared similar to those in Sardinia but they showed an higher survival rate (70%).

In order to compare natural and artificial settled stages, we decided to collect deep rocky samples (-100 m) during the same period in Sardinia. We found several stages very similar to those obtained artificially. All examined individuals were settled on coralligenous formations and on dead coral branches or bases; they were often present in microcavities. We kept these samples in the same closedcircuit aquaria. After six months these forms were still alive and no appreciable growth, as described by VIGHI (cit.) for early stages of shallower colonies, was observed.

This period of life is most probably a real "bottle neck" for the biological cycle of red coral. Because of its slow growth it seems that it is possible to find young settlements of different sized diameters, with few polyps, in areas of regular recruitment all the year round.

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Note sur les Actinies de la Mediterranée (Données préliminaires)

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Les plus importantes informations pour la faune actiniologique de Méditerranée sont concentrées en quatre publications. Les actinies du Golfe de Naples ont été décrites par ANDRES (1884) et celles de la mer Adriatique par PAX et MULLER (1962). SCHMIDT (1972) ayant étudié particulièrement les actinies de la Méditerranée occidentale, a décrit 29 espèces citant partiellement les moyens de reproduction et la description du cnidome. Dans une étude sur une collection d'actinies de la mer Egée, DOUMENC *et al.*,(1985) ont ajouté 9 espèces nouvelles pour la Méditerranée orientale. Cependant, aucun de ces travaux n'arrive à nous informer sur l'ensemble des espèces valides en Méditerranée, fait auquel ce travail-ci a l'ambition d'aboutir.

La considération de la bibliographie a dénombré 54 espèces valides d'actinies en Méditerranée, regroupées en 42 genres (Tableau I). Des 54 espèces décrites, deux sont déterminées comme cosmopolites. 50 espèces ont été retrouvées au bassin occidental de la Méditerranée, c'est-à-dire le 92.6% du nombre total de ses espèces ; 14 espèces (25.9%) au bassin Ionien et Siculo - Tunisien; 35 espèces (64.8%) en mer Adriatique ; 23 espèces (42.6%) au bassin Oriental de la Méditerranée dont 20 (37%) ont été retrouvées en mer Egée ; 5 espèces (9.25%) en mer Noire.

D'après SCHMIDT (1972), les actinies méditerranéennes peuvent être distribuées en trois groupes essentiels : le premier comporte des espèces qui représentent des genres des régions septentrionales; le deuxième, celles qui représentent des genres des régions tropicales et subtropicales ; le troisième, celles de provenance Maroco - Lusitanienne. L'analyse des informations ci-dessus, a montré que 17 espèces endémiques ont été décrites en Méditerranée (*1.A.decora*, 2.B. *strumosa*, 3. *C. aurantiaca*, 4. *C. crassa*, 5. *D.luciae*, 6.*E. grubii*, 7.*H. endromitata*, 8.*H.minor*, 9.*P. mediterranea*, 10.*P. striata*, 11. *Paranemonia cinerea*, 12.*P.vouliagmeniensis*, 13.*P. rugosus*, 14. P. *sanzoi*, 15. *Ph. pulcher*, 16. 5. *entellae* et l'espèce de la mer Noire *17. S. oustromovi*). Les genres d' espèces [7,8,10,14, et 17] ont été récoltées seulement par des régions Méditerranéennes (DOUMENC & FOUBERT, 1984). Par contre, toutes les autres espèces représentent des genres tant de régions septentrionales que tropicales et subtropicales. De toutes les espèces du tableau I, quatre (A. *striata*, *E. claparadi*, *P. cinerea* et *Ph. pulcher)* sont nouvelles en Méditerranée orientale et leur présence porte le nombre de 16 anémones des mers (DOUMENC *et al.*, 1985, DOUMENC *et al.*, 1987) à 20 espèces dans ce secteur.

Le fait et l'ensemble des informations rapportées de ce travail-ci nous permet, au moins, de conclure que le nombre des espèces de Méditerranée orientale peut augmenter si les efforts de recherche sur la faune actiniologique sont renforcés.

TABLEAU I.- Liste des espèces Mediterranéennes et leurs distribution géographique.

ESPECES		DISTRIBUTION GEOGRAPIQUE
Actinauge richardi	(Marion 1882)	ATLN, Med.[OC,C,ADR, OR (EG)]
Actinia cari	Delle Chiaje 1841	Med. (OC, C, ADR.)
Actinia equina	Linnaeus 1758	Cosmopolite
Actinia striata (*)	(Rizzi 1907)	ATLN,Med [OC, ADR, OR (EG)]
Adamsia decora	Dana 1849	Med OC.
Adamsia palliata	(Boahadsch 1761)	ATLN, Med.[OC, C, ADR, OR (EG)]
Aiptasia diaphana	(Rapp 1829)	ATLN, Med.(OC, C, OR.)
Aiptasia mutabilis	(Gravenhorst 1831)	ATLN, Med.[OC, C, ADR, OR (EG)]
Aiptasiogeton pellucidus	(Hollard 1848)	ATLN, Med.[OC, OR(EG)]
Alicia mirabilis	Johnson 1861	ATLN, ATLC, Med OC.
Amphianthus dohrnii	(Koch 1878)	ATLN, Med.[OC, C, ADR.]
Andresia parthenopea	(Andres 1884)	ATLN, Med.[OC, ADR, OR(EG)]
Anemonactis mazelii	(Jourdan 1880)	ATLN, Med.[OC, ADR.]
Anemonia insessa	Gravier 1918	ATLN, Med.OC.
Anemonia viridis	(Forskal 1775)	ATLN, Med.[OC, C,ADR, OR(EG)]
Anthopleura ballii	(Cocks 1850)	ATLN, Med.[OC,ADR.]
Anthopleura rubripunctata	(Grube 1840)	ATLN, Med.[OC, ADR, OR.]
Anthopleura thallia	(Gosse 1854)	ATLN, Med.OC.
Aureliana heterocera	(Thompson 1853)	ATLN, Med.[OC, ADR.]
Bunodactis verrucosa	(Pennant 1777)	ATLN, Med.[OC, ADR, OR(EG)]
Bunodeopsis strumosa	Andres 1881	Med.[OC, ADR.]
Calliactis parasitica	(Couch 1842)	ATLN, Med.[OC, C, ADR, OR(EG)]
Cereus pedunculatus	(Pennant 1777)	ATLN, ATLE, Med.(OC, C, ADR, OR, EG.)
Condylactis aurantiaca	(Delle Chiaje 1825)	Med.[OC, C, ADR, OR(EG)]
Corynactis viridis	Allman 1846	ATLN, Med. OC.
Cribrinopsis crassa	(Andres 1884)	Med.[OC, ADR.]
Diadumene luciae	(Verrill 1898)	Med.[OC, ADR.]
Edwardsia claparedi (*)	(Panceri 1869)	ATLN, Med.[OC, ADR, OR(EG),MN]
Edwardsia grubii	Andres 1883	Med. [OC, ADR.]
Edwarsiella carnea	(Gosse 1856)	ATLN, Med OC.
Gonactinia prolifera	(Sars 1835)	ATLN, Med. ADR.
Halcampella endromitata	(Andres 1880)	Med. OC.
Halcampoides purpurea	(Studer 1878)	Cosmopolite. Med. OC.
Haliplanella lineata	(Verril 1869)	ATLN, Med.[OC, ADR, MN]
Heliactis minor	Andres 1884	Med. OC.
Hormathia coronata	(Gosse 1858)	ATLN, Med.[OC, C, ADR, OR(EG)]
Mesacmaea mitchellii	(Gosse 1853)	ATLN, Med.(OC,ADR,OR(EG)]
Milne-Edwarsia loveni	Carlgren 1892	ATLN, Med OC.
Paracalliactis mediterranea	Ross & Zamponi 1982	Med. OC.
Paractinia striata	(Risso 1826)	Med. OC.
Paranemonia cinerea (*)	(Contarini 1844)	Med.[OC, ADR, OR(EG)]
Paranemonia vouliagmeniensis	Doumenc et al., 1987	Med. OR (EG)
Paranthus rugosus	Andres 1881	Med.[OC, ADR]
Paraphellia sanzoi	Calabresi 1926	Med.OR.
Peachia cylindrica	(Reid 1848)	ATLN, Med.[OC, ADR, MN]
Phymanthus pulcher (*)	Andres 1883	Med.[OC, ADR, OR(EG)]
Sagartia elegans	(Dalyell 1848)	ATLN, Med. [OC, ADR.]
Sagartia socialis	Gravier 1918	ATLN, Med. OC.
Sagartia troglodytes	(Price 1847)	ATLN, Med. [OC, ADR]
Sagartiogeton entellae	Schmidt 1972	Med.[OC, ADR]
Sagartiogeton undatus	(Müller 1788)	ATLN, Med.[OC, C, ADR, OR(EG) MN]
Scolanthus callimorphus	(Gosse 1853)	ATLN, Med. [OC, ADR]
Synhalcampella oustromovi	Wyragéwitch 1905	Med. MN.
Telmatactis forskalii	(Ehrenberg 1834)	ATLN, Med.[OC, C, ADR, OR(EG)]

Abréviations
ATLN= Atlantique Nord
ATLE= Atlantique Est
Med.= Méditerranée
(*)= nouvelle récolte

OC= Occidentale
OR= Orientale
C = Centrale
ADR= Adriatique
EG= Égée
MN= Mer Noire

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Programme de Contrôle Océanographique de la Baie d'Izmir entre 1988 et 1989 (Turquie): aspects biologiques

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La baie d'Izmir est une extension de la Mer Egée 60 km à l'intérieur de l'Antolie occidentale. Elle reçoit les effluents domestiques de la ville d'Izmir (plus d'un million et demi d'habitants) et les effluents industriels (tanneries, industries métallurgiques, chimiques, alimentaires et cimenteries...). S'y déversent en outre des rivières chargées de produits chimiques de provenance agricole. Enfin, y nettoient leur cale les bâteaux accueillis dans ce port d'Izmir (le plus important de Turquie). Par ailleurs, ces dernières années, dans le cadre de l'aménagement urbain, et pour augmenter la capacité du port, d'importants travaux de remblai du littoral ont été exécutés. De plus les eaux de la partie intérieure de la Baie ne sont pas suffisamment renouvelées à cause de sa morphologie. Car la partie intérieure est reliée à l'extérieur par un chenal étroit et pas très profond. Tous ces phénomènes sont les principales causes de la pollution dans la Baie d'Izmir.

Devant l'effet de la pollution, (phénomènes d'eau rouge, émission de gaz de sulfure d'hydrogène, limitation de la vie aquatique...) la Municipalité a démarré une série de travaux: constructions de grandes canalisations, amélioration du drainage des effluents des différentes usines, étude de stations d'épuration etc.. dans le but de contrôler la pollution et de rééquilibrer l'écosystème de la Baie, si possible. Dans ce cadre, en collaboration avec le département d'Hydrobiologie de la Faculté des Sciences de l'Université d'Egée nous avons commencé dès le début de l'année 1988 à étudier les différents aspects, physique, chimique, bathimétrique, biologique, de la Baie sur la base d'un contrat avec la Municipalité, en utilisant notre navire de recherche *K. Piri Reis*. Ce travail présente les aspects biologiques de ce programme.

Nous faisons différents types de prélèvements, d'une manière mensuelle, dans 32 stations de notre région d'étude. Nous avons mesuré les paramètres microbiologiques dans 15 d'entre elles, physico-chimiques dans l'ensemble des stations. Nous avons étudié les organismes benthiques dans 12, planctoniques dans 9 et ichtyoplanctoniques dans les 20 stations. De plus les niveaux des métaux lourds dans les organismes, dans le sédiment, et dans l'eau de mer ont été mesurés et comparés dans 10 stations.

D'après les résultats obtenus, les organismes vivants de la Baie sont :

- organismes planctoniques, **Microplancton**, Prasinophyceae (1 sp.), Chrysophyceae (3 sp.), Bacillariophyceae (56 sp.), Pyrrophyceae (80 sp.), Euglenophyceae (1 sp.), Ciliata (20 sp.), **Holoplancton**, Cladocera (6 sp.), Copepoda (20 sp.), Mollusca (1 sp.), **Meroplancton**, Crustacea (25 sp.), Decapoda (7 sp.), Tunicata (18 sp.), Coelenterata (4 sp.), Chaetognatha (25 sp.), **Ichtyoplancton** (39 sp.).
- organismes benthiques, **Phytobenthos**, Rhodophyta (17 sp.), Chlorophyta (10 sp.), Phaeophyta (9 sp.), Cyanophyta (5 sp.), Spermaphyta (3 sp.), **Zoobenthos**, Porifera (3 sp.), Coelenterata (6 sp.), Polychaeta (79 sp.), Crustacea (47 sp.), Mollusca (34 sp.), Echinodermata (18 sp.), Tunicata (6 sp.).
- poissons demersales demersales (33 sp.) (GOKCEN and CIRIK, 1989).

On constate une diminution du nombre d'espèces dans tous les groupes d'organismes vers l'intérieur de la Baie. La vie aquatique est très limitée dans la zone du port. Les espèces qui ont de larges capacités d'adaptation existent en général dans la Baie moyenne. Parmi l'ichtyoplancton, des oeufs et des larves d'anchois se trouvent dans toutes les stations. Cette espèce limite certainement le développement d'autres poissons pélagiques, en particulier les sardines. Du point de vue microbiologique le nombre des coliformes fécaux est supérieure aux limites autorisées pour la baignade dans la baie intérieure. On a observé également une accumulation des métaux lourds (Hg, Cd, Pb) dans les organismes et dans le sédiment dans la baie intérieure mais pas au-dessus du niveau critique.

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B

A biometrical study on deep red coral, *Corallium rubrum (L.)*, in NW - Sardinia

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In spite of the special importance of Sardinian waters for red coral fishing, some basic aspects of the exploitation of this species are still unknown (CUDONI & CHESSA, 1991). This is particularly true for colonies at 90 m and deeper, due to the obvious difficulties in studying them. In particular, the analysis of population parameters in a given region can provide the basis for their stock assessment and fix priorities in research and management (FAO, 1983). The aim of this work is to give preliminary data of this kind in order to contribute also to the improvement of the fisheries Regional Law.

Colonies of a base diameter > 4 mm were collected by professional divers 12 miles SW of Capo Caccia (NW Sardinia) from a depth of 90 to 105 m, during summer 1991. In a sample of 106 intact branches, 42 of them were monoplanar and 64 pluriplanar. The base diameter (mm), the maximum height (mm) and the weight (9), were considered for biometrical purposes. The frequency distribution of the base diameter (D), the height (H), and the weight (W) give average values of respectively mm 9.5±2.1s, mm 152±36s, and g 34±20s (Figs. 1, 2, 3). Considering also the maximum values of these parameters : mm 16 (D), mm 260 (H) and g 128 (W), there is evidence of the lack of strong fishing pressure. This can be explained by the fact that this area was closed for 11 years to red coral fishing.

In order to show the relationship between age classes and base diameter, six age classes, established using the formula : age = D/1.32, as suggested by GARCIA-RODRIGUEZ & MASSO (1986b, c), are plotted against the cumulative % frequency of D (Fig. 4). It emerges that the most abundant classes are those between 5-6 (II) and 6-7 (III) years, and that the maximum age reached by a colony is 12 years. It is also evident that D sizes ≥ 10 mm are the most exploited ones.

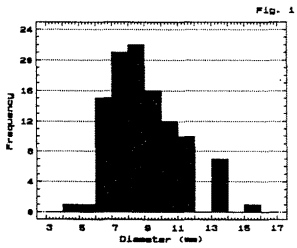
Regressions between W and H (not shown here) and between W and D (Fig. 5) were calculated. While the first is similar to that found by GARCIA-RODRIGUEZ & MASSO (1986a) for a red coral population off Gerona, the second is very different : $W = 0.606\ D^{1.74}$ (our data); $W = 0.086\ D^{2.198}$ (Authors cited). So, taking into consideration colonies with the same diameter, the weight of ramifications found off Alghero is almost double of those found off Gerona. This fact can be explained by two different hypotheses :

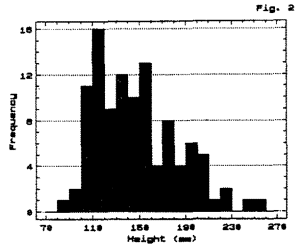
1°) differences in the number of branches of the colonies;

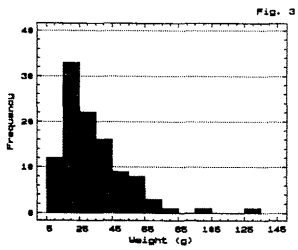
2°) differences in the compactness of the skeleton.

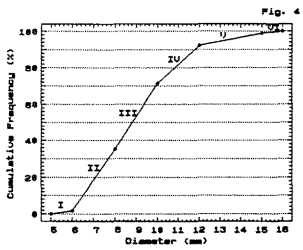
Our subsequent application of the above mentioned regressions to other samples from the same fishing area off Alghero (unpublished data), confirms that H is not a good parameter for the characterization of *Corallium rubrum* populations, and that D is better. This is undoubtedly due to the allometric growth of this species and is in agreement with the findings of GARCIA-RODRIGUEZ & MASSO (1984a).

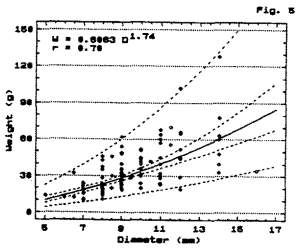
Figs. 1, 2, 3. Frequency distribution of respectively : diameter, height and weight.
Fig. 4. Cumulative frequency of age classes.
Fig. 5. Regression of weight on base diameter.











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Benthic bacterial abundance and distribution in different areas of the Mediterranean Sea : relationships with organic matter

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It is well-known that benthic bacterial distribution is closely related to the sediment properties (such as grain size and organic content (DALE, 1974; DE FLAUN and MAYER, 1983). This paper summarizes data on the spatial distribution of benthic bacterial populations in different areas of the Mediterranean Sea in relation to the sediment organic matter content in order to point out factors relating to the bacterial distribution.

Surface sediment samples were collected from 8 Stations facing the river Entella, (July 1989), 5 Stations at the Portofino Promontory (July 1990), 1 Station in Posidonia bed sediment (from Dec. 90 to Dec. 91), 15 Stations at the mouth of the river Arno (November 1989), all-these from the Ligurian Sea and 22 Stations in Ionian and Aegean Seas (September 1989) using an Usnel 0.1 m^2 box-corer.

Sediment Organic Matter (TOM) was determined by the difference between the dry weight of the sediments (24 h, 60 °C) and the residue left after combustion (4 h, 550 °C).

Sediment Bacteria. Total bacterial number (TBN) in each sediment replicate (n=3, 1 cm^3) was analysed as described in MONTAGNA (1982). Bacterial Biomass (BBM) was calculated converting biovolume into carbon content, assuming 308 fgC x μm^3.

The entire data set did not show a significant correlation between TOM and BBM. Among the environmental conditions that can affect the benthic bacterial distribution and activity, two factors appeared to be significant in explaining the lack of correlation:

1) geographic and biogeochemical differences between the considered environments which determine the different foodsupply for benthic organisms.

2) large differences in hydrodynamic conditions (measured by using currentmeters placed at the water/sediment interface) in non food-limiting environments, as in coastal areas. Analysing the relationships between TOM and TBN or BBM in each area different patterns were found.

Entella Mouth was characterized by large amounts of organic matter (from 32.2 to 82.6 mg g^{-1} sed. d. w.) with an increasing gradient from shallower to deeper stations. This trend is related to the hydrodynamic conditions which are responsible for higher degree of resuspension in the shallower stations. Significative TOM vs TBN and TOM vs BBM correlations were found ($p<0.01$).

Arno Mouth. In sediments facing the river Arno (from 15 to 58 m depth) organic matter failed to correlate with bacterial density or biomass. This area was characterized by large amounts of sediment organic matter (from 52.1 to 80.9 mg g^{-1} sed. d. w.), mostly composed of refractory material because of the influence of riverine waters. Sediment texture appears to be largely homogeneous and a gradient of hydrodynamic stress between stations is lacking. This area is highly polluted because of the large heavy metal input from the river, and a negative relationship between Cadmium concentrations (FABIANO *et al.*, in prep.) and bacterial biomass was found.

Ionian and Aegean Seas. Analysis of sediment organic matter in the deep-sea generally shows very low concentrations (from 5.6 to 15.1 mg g^{-1} sed. d. w.). TOM significantly correlates with depth but not with benthic bacteria. The Eastern Mediterranean deep-sea can be considered a food limitating environment because of the low concentrations and mostly refractory composition of TOM. The factor controlling bacterial distribution was the amount of labile compounds (i.e. carbohydrate, lipid and protein). A significant relationship between bacterial number and carbohydrate content (unpubl. data) was found ($p<0.05$).

Posidonia Bed Sediments. In the studied sheltered bay (very low hydrodynamism), three main inputs of organic matter can be distinguished: algal bloom and decay, Posidonia leaf-fall and terrestrial input of organic matter brought to the sea by rains. Bacterial density and biomass show strong seasonal fluctuations but were not related to the amounts of sediment organic matter. Since food supply was never a limiting factor (TOM was annually on average 32 mg g^{-1} sed. d. w.) bacterial abundance depended on temperature (n=22, $p<0.01$) and on phosphate concentrations in interstitial waters (n=22, $p<0.001$).

To conclude, an analysis of the bacterial distribution along an hypothetical profile from 0 to 2400 m depth is shown in Fig. 1. The general trend seems to follow a bimodal curve with maximum bacterial densities in shallow water with little water movement (Posidonia bed sediments) and in deeper low energy environments rich in organic matter (muds from 60 to 135 m) confirming the results of NOVITSKY and MacSWEEN (1989) which observed higher TBN in protected sandy sediments than those which were exposed. Table I shows the environmental conditions characterizing the areas considered. The reported values were defined from very low (--) to very high (++++).

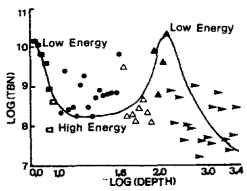

Fig.1

SEDIMENT TYPE	FOOD SUPPLY	ENVIRON. ENERGY	BACTERIAL BIOMASS
Posidonia	+ + +	–	+ + + +
Sandy Sediment	+	+ + +	–
Sandy Mud Sediment	+ +	+ +	+
Mud Sediment	+ + +	–	+ + +
Deep Sea Sediment	–	– –	+

Tab. I

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Marine fouling and periphyton growths on test panels in the Eastern Harbour of Alexandria

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The periphyton and fouling assemblage on exposed test panels were studied in the Eastern Harbour of Alexandria, during October 1990 to November 1991. A little is known about the annual numerical abundance of periphyton species growth in one and two weeks exposure periods successively over the year in relation to the fouling biomasses and composition. The E.H. is a relatively semi-closed bay covering an area of ca. 2.8 km^2 with water depth of about 6 m. The waters of the harbour are subjected to considerable amount of land and sewage drainage discharged annually average about 35.18 x10^6 m^3 (DOWIDAR *et al* .,1987).

The periphyton observation was carried out on the scraped fouling assemblage on one panel side which preserved with 5% formaline. Subtotals were counted for each species and categorized according to diatoms (*Baccillariophyceae*), *Dinophyceae*, blue-green algae (*Cyanophyceae*), *Chlorophyceae*, *Rhodophyceae*, and *Phaeophyceae*. The results are expressed as number of cells /100 cm^2 of the panel area.

The amplitude of seasonal changes in temperature of seawater at surface was 12° C. The values of water temperature raised to 28° C in July and the value measured 16° C in January. The salinity of seawater was 38.93 ‰ at surface layer in May and 39.36 ‰ at 4.5 m depth in October.

The periphyton term is confined to Algae growing on artificial surfaces exposed in seawater ROUND, 1982). Periphyton species colonized on panels after one and two weeks included 96 species, 59 of which are diatoms. *Navicula* spp. and *Nitzschia* spp. developed well and were found in large numbers 403,191 and 1118340 cells 10^{-2} cm^2 of the panel area after one week immersion. Rich growth of periphyton species were extensively grown depending upon the duration of exposure which were more dense after two weeks than one week.

The picture of fouling assemblage on the submerged test panels at the E.H. of Alex. was very poor. The fouling data obtained on these short term exposures panels included microscopic and macroscopic fouling organisms were treated to know the seasonal rate of settlement, the rate of growth and the time of maximum attachment over the year.

The fouling organisms developed on the submerged panels after one and two weeks successively over the year included 7 main fouling groups. These groups are Algae, Hydroids, Bryozoa, Polychaeta, Cirripedia, Amphipoda, and Isopoda.

1) Algae : Five species of algae, *Ulva lactuca* L., *Enteromorpha compressa*, *Chaetomorpha aerea*, *Cladophora prolifera* and *Ectocarpus irregularis* are the dominant component of the early phase of macro-organisms on which the subsequent growth of fouling take place. They predominated more on 2-week exposure panels than on one-week exposures in particular during spring and summer seasons which the average of water temperature was 25.2° C and salinity was 38.04 ‰.

2) Hydroid : *Obelia geniculata* was the only coelentrate recorded on the submerged test panels after one or 2 weeks periods.

3) Bryozoa : Erect form, *Bugula neritina* was the most abundant fouling organisms in sea water showed marked seasonal variations in its abundance. It appeared over the year and the period of dense settling occurred when water temperature exceeded 20° C in April to September 1991, yielded 15-57 colonies 10 cm^2 after one week and in April to June numbered 213-392 colonies 10 cm^2 after 2 weeks exposure

4) Polychaeta : calcareous tube worms, *Hydroides elegans* was the dominant species which successfully colonized on the submerged surfaces during most of the year. It appeared in large numbers of tubes during October and November 1990, (average temperature 22° C and salinity 38.46 ‰) which yielded 818-948 tubes 10 cm^2 on one week panels, respectively. On 2 weeks exposures *H. elegans* predominated in fall (October to November 1990) which the maximum numbers encountered was 1145 and 916 tubes.

5) Cirripedia : barnacles, *Balanus amphitrite* var. *denticulata* and *B. eburneus* were the most constituent of fouling in the E.H. of Alex. (BANOUB, 1960, MEGALLY, 1970, GHOBASHY,1976 and EL-KOMI, 1991). *Balanus amphitrite* was the dominant through August to November 1991, water temperature averaged 23.8° C and salinity 38.22 ‰, which 16-63 individuals 10 cm^2 in one week exposure period were recorded. *B. eburneus* was less frequent on the panels than *B. amphitrite*.

The biomass is less than one gram in one week exposure over the year. In general the fouling biomass was larger on panels after 2 weeks immersion than after one week depends upon the duration in seawater.

Rich growth of branched and unbranched algae as filaments of green, brown, red algae and diatoms are extensively grow on the submerged test surfaces which depend upon the duration of the exposure. The community and species composition of plankton attached to panels in the E.H. was very different in comparison to that actually grow in water column. This is due to the considerable division of the cells of diatoms, Dinophyceae, Cyanophyceae which grow on surfaces for one and two weeks over the year.

The seasonal fluctuation of settlement is clear from these results both the rate of growth and settlement raising to a maximum value in fall except for *Bugula neritina* occurred in spring. These data were low in winter which the temperature is markedly decreased below 20° C. The fluctuation take place in the numbers of organisms settling and their rate of growth as results of the environmental influences such as temperature, dissolved oxygen, organic matter and the degree of pollution inside this semi-closed bay. FLETCHER and CHAMBERLAIN (1975) stated that the first settlers on surfaces are bacteria and unicellular diatoms which are gradually replaced by colonial diatoms especially *Navicula* and in turn are overgrown by green algae, as *Enteromorpha* and brown algae, as *Ectocarpus*. The breeding of *Bugula neritina* and *Hydroides elegans*, *Balanus amphitrite* and algal development of *Ectocarpus irregularis* is continued over the year. Major spawning periods probably coincide with the warmer seasons when temperature raised above 20°C. The growth of microscopic filamentous of algae and diatoms affects on the attachment of the subsequent macro-fouling organisms.

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Croissance de la palourde *Ruditapes decussatus* (Linné, 1758) dans la lagune de Monastir (Tunisie)

Najoua EL-MENIF et Fredj KARTAS

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L'étude porte sur le suivi de la croissance de la palourde en fonction de la densité et des conditions du milieu naturel durant la période allant de mars 1987 à février 1988. De jeunes palourdes sont placées dans des cages construites autour d'une armature en P.V.C de 54 x 54 x 16 cm entièrement recouverte d'un filet de 9 mm de maille, et installées dans différentes stations de la lagune de Monastir et dans le canal d'évacuation des eaux de l'écloserie et des races-ways (Fig. 1). A intervalles mensuels, nous avons procédé aux mesures de la température de l'eau ainsi qu'au prélèvement au hasard de 50% d'individus dans chaque cage afin d'en évaluer la taille et le poids. Les échantillons sont remis ensuite dans la cage correspondante. Le sédiment est vaseux dans la station E, sablo-vaseux dans la station B, et sablo-coquillé dans la station C. Afin d'apprécier l'effet de la densité sur la croissance, deux densités sont prises arbitrairement : d_1 = 200 ind/m^2 et d_2 = 400 ind/m^2.

Effet de la densité sur la croissance. Pour les deux densités, les individus de la station B présentent des tailles et des poids moyens pratiquement les mêmes durant les mois de mars, avril et mai. De juin à février, la différence devient significative et est au profit des individus de la cage à faible densité. Ainsi, il apparaît que, tant que les individus sont petits et ne dépassant pas une certaine taille (28 mm), l'effet de la densité sur la croissance ne se fait pas sentir.

Pour la station E, les moyennes linéaires et pondérales sont pratiquement les mêmes durant toute l'année. Il serait utile d'augmenter graduellement la densité afin de déterminer la densité optimale que ce milieu est susceptible d'accepter.

Effet du milieu sur la croissance. Nous avons pris en considération uniquement les cages à densité élevée 400 ind/m2.

La présentation graphique des valeurs moyennes de la taille et du poids (Fig: 2-3) fait apparaître deux phases principales :

- Une première phase correspondant à une croissance rapide s'étendant de mars à juillet.
- Une deuxième phase qui va d'août à février durant laquelle la croissance est lente.

Au cours de la première phase, la croissance linéaire est importante. Elle est pratiquement similaire dans les stations E et B, alors qu'elle est plus faible dans la station C.

Pendant la deuxième phase, le taux de croissance est presque le même dans les trois stations. Les différences de croissance à l'issue de la première phase se maintiennent tout le long de la deuxième phase.

S'agissant de la croissance pondérale, nous avons relevé deux périodes au cours de la première phase. Une période de trois mois caractérisée par une croissance analogue dans les trois stations, et une deuxième période allant de juin à août, où le taux de croissance subit un accroissement particulièrement rapide dans la station B et surtout dans station E alors qu'il se maintient à un niveau faible dans la station C.

Quoique plus faible au cours de la deuxième phase, le taux d'accroissement reste relativement important dans les stations E et B et très faible dans la station C, ce qui accroît l'écart.

Pour un semis de printemps, les résultats enregistrés montrent que la station E est le milieu le plus favorable. Ceci est vraisemblablement dû à la nature du substrat, à la température de l'eau, et à la richesse trophique du milieu assurée par le renouvellement continu des eaux.

A Monastir, le maximum de croissance est relevé entre mars et juillet, quand les fluctuations thermiques oscillent entre 14 et 29°C. Alors que dans l'étang de Thau, MAITRE-ALLAIN (1983) signale que la croissance la plus importante est observée quand la température est comprise entre 10 et 20°C. Au delà de ces valeurs, la croissance est quasi nulle, bien que le taux de chlorophylle se situe entre 0,7 et 5,5 mg/m^3. PIQUION et FLASCH (1985) et BODY *et al.* (1986) ont montré que jusqu'à la température de 25°C, la palourde se trouve dans des conditions optimales. Entre les mois d'août et décembre, nous avons relevé un ralentissement de la croissance, puis une reprise dès le mois de janvier. Ce constat se rapproche de celui de MAITRE-ALLAIN (1983) qui a observé en hiver une croissance assez bonne malgré une concentration faible en chlorophylle (0,3 à 2mg/m^3).

Emplacement	N° de la cage		M	A	M	J	J	A	S	O	N	D	J	F
Lagune Est -B	3	N	50,00	24,00	23,00	21,00	23,00	24,00	24,00	24,00	28,00	24,00	28,00	25,00
		L	22,20	26,11	27,60	30,19	33,20	34,20	34,71	34,75	34,89	34,88	34,90	35,08
		W	1,79	3,30	4,05	4,94	6,95	7,51	7,84	8,21	8,23	8,20	8,13	8,17
Canal -C	4	N	100,00	50,00	48,00	48,00	46,00	43,00	38,00	38,00	37,00	35,00	35,00	37,00
		L	22,04	25,06	27,00	28,61	31,73	31,74	32,20	31,82	32,30	32,42	32,61	33,57
		W	1,79	3,22	3,91	4,48	6,05	5,73	6,22	6,34	6,37	6,54	6,62	7,24
Race-way -E	8	N	100,00	48,00	39,00	34,00	32,00	20,00	20,00	25,00	31,00	25,00	25,00	23,00
		L	22,04	24,30	25,80	27,17	28,28	28,11	28,45	28,41	28,64	29,08	29,07	29,32
		W	1,79	3,12	3,50	3,82	4,24	4,26	4,31	4,41	4,58	4,59	4,82	5,04
	10	N	50,00	25,00	26,00	24,00	23,00	24,00	26,00	23,00	21,00	24,00	19,00	20,00
		L	22,04	24,61	27,72	30,45	30,91	33,25	34,23	34,69	34,71	36,33	36,05	37,95
		W	1,79	2,96	4,32	5,88	6,58	7,69	7,90	9,09	9,02	9,96	10,42	11,25
	12	N	100,00	50,00	47,00	50,00	42,00	45,00	40,00	28,00	30,00	30,00	28,00	24,00
		L	22,04	24,60	27,33	29,92	23,76	34,31	35,52	35,61	35,63	36,46	36,58	38,06
		W	1,79	2,78	3,95	5,35	7,63	8,24	8,53	8,93	8,97	9,75	9,95	11,43

Tabl. 1: Valeurs moyennes de la longueur et du poids de la palourde dans différentes stations (N= effectif; L= longueur moyenne antéro-postérieure;W= poids moyen).

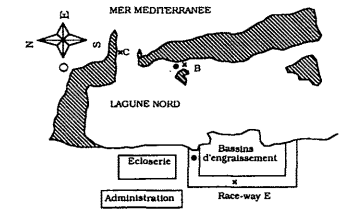

Fig. 1: Emplacement des cages : d= 200ind/m^2 ● d= 400ind/m^2 ×

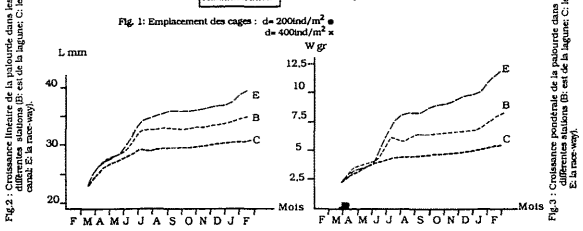

Fig.2 : Croissance linéaire de la palourde dans les différentes stations (B: est de la lagune; C: le canal; E: la race-way).

Fig.3 : Croissance pondérale de la palourde dans les différentes stations (B: est de la lagune; C: le canal; E: la race-way).

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Données biométriques sur la palourde *Ruditapes decussatus* (Linné,1758) dans les Lagunes de Bizerte et Monastir (Tunisie)

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Nous avons effectué une étude morphométrique sur deux échantillons de palourdes prélevés, en automne 1987, dans la lagune de Bizerte et dans le canal d'évacuation des eaux de l'écloserie et des bassins d'engraissement du Centre National d'Aquaculture de Monastir. L'échantillon de Bizerte est composé de 140 individus de taille comprise entre 10,3 et 50 mm. Celui du lac de Monastir comprend 160 individus de taille variant entre 7 et 45mm.

L'étude consiste à établir des équations linéaires liant, d'une part, la longueur totale (L) à la hauteur (H) et à l'épaisseur (E) et, d'autre part, la hauteur à l'épaisseur, et à calculer les indices morphométriques correspondant aux rapports en pourcentage de deux variables.

Relation Longueur-Hauteur : Dans les deux secteurs, la valeur du coefficient de corrélation, proche de l'unité, montre une étroite relation entre ces deux variables. Les valeurs extrêmes des indices font apparaître une croissance isométrique pour l'échantillon de Monastir et une nette allométrie minorante pour celui de Bizerte (Fig: 1).

En nous référant à l'équation signalée par ARNAUD et RAIMBAULT (1963) pour l'étang de Thau et à celle de GRAS et GRAS (1981) pour le Bassin de Marenne-Oléron, nous remarquons que le taux de croissance est presque le même dans la lagune de Bizerte et dans l'étang de Thau, d'une part, et dans la lagune de Monastir et dans le bassin de Marenne-Oléron, d'autre part.

Relation Longueur-Epaisseur : la valeur du coefficient de corrélation, très élevée dans les deux secteurs tunisiens, fait apparaître une très bonne corrélation entre les deux paramètres. Les valeurs extrêmes de l'indice montrent une croissance différente entre les deux secteurs se traduisant par une isométrie à Bizerte et une allométrie majorante à Monastir (Fig: 1).

En nous référant à l'équation donnée par GRAS et GRAS (1981) dans le bassin de Marenne-Oléron (Tab: 1), nous pouvons relever que la croissance est similaire avec Bizerte mais différente de celle de Monastir.

Relation Hauteur-Epaisseur : Les valeurs de r dans les deux secteurs montrent la bonne relation entre la croissance de l'épaisseur et celle de la hauteur. Les valeurs extrêmes de l'indice E/H font apparaître une croissance plus majorante à Monastir qu'à Bizerte (Fig: 1).

En appliquant l'équation donnée par GRAS et GRAS (1981) (Tab: 1), nous constatons que la croissance de l'épaisseur est meilleure dans le Bassin de Marenne-Oléron que dans les secteurs étudiés.

Localité	N	Equation	r	Valeurs extrêmes des indices
Lac de Monastir	160 160 160	H=0,684L+0,010 E=0,485L-1,263 E=0,708H-1,253	0.9978 0.9890 0.9898	68,49 → 68,45 40,98 → 45,56 59,81 → 66,51
Lac de Bizerte	140 140 140	H=0,630L+1,331 E=0,431L+0,064 E=0,708H-0,754	0.9942 0.9898 0.9896	70.86 → 66.78 43.44 → 43.24 61.34 → 64.65
Etang de Thau Arnaud et Raimbault (1963)	—	H=0,650L+0,810	—	—
Bassin de Marenne-Oléron Gras et Gras (1981)	657 657 657	H=0,663L+0,073 E=0,419L+0,079 E=0,618H+0,060	0,973 0,958 0,962	— — —

Tabl. 1 : Paramètres des équations linéaires entre Hauteur(H)-Longueur(L), Epaisseur(E)- Longueur (L) et Epaisseur(E)- Hauteur(H). (N= Effectif , r= coefficient de corrélation)

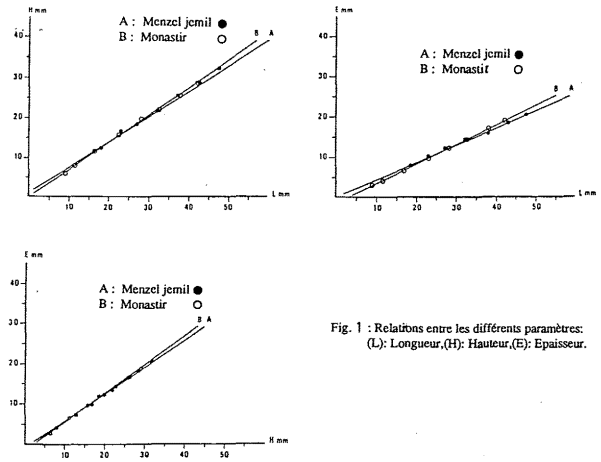

Fig. 1 : Relations entre les différents paramètres: (L): Longueur,(H): Hauteur,(E): Epaisseur.

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The latest status of Polychaeta in the soft substrate of Izmir Bay

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Izmir Bay is located in the west part of Turkey on the coast of the Aegean sea. Topographically and hydrographically it is divided into three parts designated as inner, middle and outer part. Heavy pollution in the inner part of the Bay is gradually spreading towards the outer part.

Studies on the benthic and pelagic organisms together with physico-chemical characteristics of the Bay were concentrated in the last 20 years (ERGEN 1976, 1985, KOCATAS, *et al.*, 1988, among others).

The aim of this study is to investigate the latest status of the Polychaetes distributed in the soft substrate of the Izmir Bay, which are one of the most important groups among the benthic organisms.

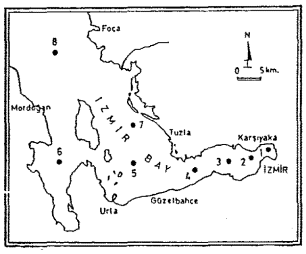

Fig. 1.- Sampling stations

For this, during the period between August 1988 and July 1989 sampling was carried out once every two months from the 8 stations selected in the Bay using Van Veen grab (Fig. 1). A 10 dm³ volume of sediment was considered and Shannon-Weaver formula was used for the calculation of the diversity indices. During the investigation period, out of a total of 48 samplings, 115 Polychaeta species have been determined. Of these, 10 species (*Harmothoe lunulata, Kefersteinia cirrata, Hyalinoecia bilineata Hyalinoecia fauveli, Onuphis conchylega, Scoloplos armiger, Notomastus profundus, Clymene palermitana, Trichobranchus glacialis, Polycirrus aurantiacus*) are new for the Aegean and Mediterranean coasts of Turkey; 8 species (*Paralacydonia paradoxa, Glycera capitata, Onuphis quadricuspis, Prionospio steenstrupi, Prionospio pinnata, Chaetozone setosa, Brada villosa, Rhodine cf. loveni*) are being reported newly for all Turkish coasts.

When the stations are compared in regard to the number of species, number of individuals and diversity index (Fig, 2), it can be observed that the stations situated in inner Bay (St.1, 2, 3) exhibit less number of species and lower diversity index value. This is mainly due to the heavy pollution occurring in this region.

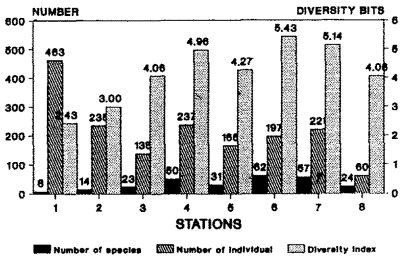

Fig. 2.- Distribution of number of species and number of individuals at the stations and diversity index values.

Some stations situated in the outer part of the Bay (St. 5 and 8) are also relatively poor in the number of species and show low diversity index values in comparison to other stations in middle and outer parts of the Bay (St. 4, 6 and 7). The nature of the bottom sediments seems to be responsible for these phenomena. In effect bottom sediment taken from the most inner part of the Bay for deepening purposes is dumped at st. 5, while at st. 8 which is the deepest station (70 m), bottom sediment is characterized by homogenous mud.

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The non Lessepsian migration of *Ruppia maritima* to the Suez Canal

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The Suez Canal had been considered as the possible passway for many species of benthos to migrate between the Red Sea and the Mediterranean, a phenomenon known as "Lessepsian Migration" proposed by POR (1978).

The marine plants of the Suez Canal was the subject of investigations since 1908. Recently ALEEM (1980), and FARGHALY (1985), discussed the seaweeds of the canal.

A new record of a benthic plant in the Suez Canal had been published by FARGHALY and DENIZOT (1988) identified as *Ruppia maritima* L. after ASCHERSON *et al.*, 1907, and considered as a new invader to the Suez Canal. Further observations and investigations had been carried out by the author in both the Great Bitter Lake of the Suez Canal and the Bardawill Lake north Sinai, in the Eastern Mediterranean, in order to clarify the ecology, and the possible passway permited this plant to migrate and colonize a part of the Lake bottom. These efforts may answer the question : from where this plant came ? and to which extent it will spread over the bottom of the Lake ?

The ecological results obtained for two years investigations proved that the Bitter Lakes play an important role on the migration of benthic plant and animal species via the Suez Canal. They could been a reservoir for some and a barrier for others.

The hydrography of the Lakes followed for three years during (1988-1991), reflected the following figures :

1.- Water temperature of the Lakes was always lower than the corresponding air temperature by about 0.5-7°C. The maximum temperatures were in July and August reaching about 30.5°C, while the minimums were in January and February being arround 15°C.

2.- An Electric Power Plant of moderate size and capacity in the northeastern corner of the Great Bitter Lake cause an increase in water temperature of about 3-9.5°C in an area of about $5km^2$.

3.- The salinity of the Lakes water had high values; minimum of about 40‰ and maximum of about 46‰.

These figures and investigation on other parameters; PH-0^2 nutrients gave indications that the hydrographic conditions in both Bardawill and Bitter Lakes are more or less similar. These findings make it possible to think about the transportation of *Ruppia* seeds by some migrant birds transiting the small islets of the Great Bitter Lake after landing on the Bardawill bancs.

Ruppia maritima L. had extended during the last 3 years on the bottom neer the EPP spreading over an area of about 1 km. On other growth or colonization had been observed along the Suez canal or on the gulf of Suez or the Eastern Mediterranean.

In conclusion of these results we consider this plant as a new "non Lessepsian migrant" to the Suez Canal due to the changes in the hydrographic conditions and thermal pollution caused by the EPP of Abo-Sultan in the Great Bitter Lake of the Suez Canal .

The extention of this plant in the Bitter Lakes may affect the seagrass beds of *Halophila stipulacea* and therefore the ecosystem based on.

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The seaweeds in the Suez Canal 120 years after its first opening and their potential utilization

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The Suez Canal is considered as one of the most important path ways in the world for commercial trade as well as for the migration of plants and animals between the Red Sea, one of the youngest seas, and the mediterranean, one of the oldest.

The Canal authority is intending now a days to start the second phase of the development which include the widening and deepening of this water body. These changes will affect the distribution of the marine fauna and flora of the Canal and will change its ecological adaptation in many ways.

It is of great importance to speculate the actual status of the Seaweeds, one of the major bases for the nutrition of many groups of animals, before the changes of Canal features.

More than 180 species of seaweeds had been collected from the Canal, 163 km, in the period between 1983-1991. The red algae constitute about 40% of the flora, while the greens was found to be about 30% and the brown is about 16%. The blue greens complete this list by about 14%. The distributional pattern of these algae along the Suez canal were established as they colonize the canals banks and the Lakes bottoms.

FARGHALY (1985) had divided the Canal into four major parts ; the northern part, the Timsah, the Bitter Lakes and the southern part. Six years latter we can illustrate the seaweed vegetation as follows :

A) The northern part :

About 120 species of seaweeds belonging to the four groups could been collected along the year ; 60% of indopacific origin and about 15% are not reported from the other parts of the Canal. In this part the dominance was for the red algae followed by the green.

B) The Timsah Part :

Investigations were carried out on water quality and growth of seaweeds in five different sites along 20 km in this part, for 14 months during (1985-86) FARGHALY *et al.* (1988), and followed to 1991. These investigations conclude that this part of the Canal play a negative role in the migration of the Red Sea species of algae to the north. The hydrographic conditions caused by the large amount of drainage water from the adjacent lands is the barrier for such migration. About 80 species had been identified in this part ; 46% red, 28% green, 15% brown and 11% blue green.

C) The Bitter lakes :

The Bitter lakes plays a reservoir role for the migration of Seaweeds from the Red Sea to the north. Extensive collections made all over the lakes banks and the hydrographic conditions were recorded during two years (1988-1989). These studies gave a distributional pattern of about 110 species of Seaweeds ; 50% red, 28% green, 16% brown and 6% blue green.

The electric power plant of Abu Sultan in the northeast of the great Bitter Lake raise the water temperature of about 9°C which could be the attraction power for many species found for the first time in the Canal in this study.

D) The Southern part :

This part do not differ greatly than the northern part of the gulf of Suez in the percentage of the groups ; 45% red, 25% green, 15% brown and 15% blue green. About 100 species had been collected from this part.

The seaweeds of the Suez Canal colonize any hard substrate in four major belts :

1) The first belt at high water level of blue greens associated with Diatoms. Some filamentous green algae was found occasionally in summer.

2) The second belt below the high water mark extended to about 30 cm. This belt is composed mainly of green algae with small red ones. Epiphytes could be found in some parts of the Canal.

3) The third belt start about 40 cm below the low water mark and extend to 40-60 cm where macro-red algal communities has well developed growth. In some parts of the Canal brown associate with red algae.

4) The fourth belt start at 100 cm depth and include red algal communities. This belt is variable according to the stations.

These observations agrees with and complete ALEEM's (1983).

A large number of these algae are know to be of economic importance and containing natural products of economic value. Other species reported to be pollutions monitors. During the ecological studies to understand the distributional patterns of the flora, the potential utilization of the important species were estimated.

Some species of red Brown and Green algae had been used as minors of the sandy Sinai desert soil. Three crops were tested using this minor. The results proved that seaweeds could be good minors for sandy soil to grow the most popular leguminous in Egypt, broad beans.

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Preliminary results of the evolution of the gonad index of *Paracentrotus lividus* (Lamarck) in the Urbinu lagoon in Corsica (France)

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Monitoring of the gonad index of *Paracentrotus lividus* has been carried out at numerous locations : Alger (SEMROUD and KADA, 1987), Marseille (REGIS, 1978), Villefranche Bay (FENAUX, 1968), Corsica (NEDELEC, 1983), Ireland (BYRNE, 1990). The present study was undertaken in the Urbinu lagoon, south of Bastia (Corsica) where there is a large population of *Paracentrotus lividus*, whose density varies according to the biotopes (*Cymodocea nodosa* beds, shingle, sand and muddy bottoms) (FERNANDEZ, 1990; FERNANDEZ and CALTAGIRONE, 1990). This lagoon has been chosen as a site for the echinoculture of *P. lividus*. The initial part of this programme consists of gaining a better understanding of the indigenous populations (population dynamics, stock evaluation, diet, physiological indices) so as to define sites of recruitment, good growth potential, as well as the spawning period. The preliminary results, presented here, concern the definition of the spawning period which is estimated by following the evolution of the gonad index and the percentage of mature females (FENAUX, 1968).

The Urbinu lagoon offers very different trophic conditions according to the biotope. In the *Cymodocea nodosa* algal beds, the trophic factor is not limiting as the urchins readily consume this phanerogame (FERNANDEZ, 1990). It is noted that *C. nodosa* is considered as a preferential food species by *P. lividus* (TRAER, 1980). Individuals living on the shingle bottoms, where often the vegetation resources are quite small, have a very varied diet : either a diet of animal material (crustaceans, gasteropods) and fragments of vegetation or a material obtained from grazing (observation of stomach contents : FERNANDEZ, 1990).

Samples for gonad analysis of urchins living in the beds of *Cymodocea nodosa* were taken monthly from April to August 1990 and from April 1991 to January 1992. Urchins living on the shingle bottoms were sampled from April to August 1990 and quarterly from May to November 1991. Ten individuals were sampled at each sampling session; their test diameter (not including the spines) varied from 35 to 50 mm. Gonads were removed and oven dried for 48 hours at 70°C before being weighted (± 0.1 mg). The gonad index (GI) utilized is that of SEMROUD and KADA (1987) derived from the index of repletion proposed by NEDELEC (1983). It is the ratio between the gonadal dry weight and the cube of the horizontal teste diameter, expressed in mg cm^3.

This index permits the detection of the spawning period and the establishment of a relationship between the development of the gonads and the different biotopes.

The results obtained (Table 1) show that the urchins living in the algal beds have a gonad index which is always elevated in comparison to data in the literature (KADA, 1987; SADOUD, 1988). The curve of evolution of this index shows some statistically significant oscillations, particularly between May and June (Kruskall and Wallis Test and Mann Witney Test) during the two years studied. Moreover, the data concerning the percentage of mature females present during 1991 also shows a sharp decrease during the same period (Table 1). The urchins living on the shingle bottoms, have a lower overall average gonad index but equally show a decrease between May and June 1990.

These data show that spawning of the urchins takes place during May/June at both stations in the lagoon and this is in agreement with other reported spawning times from the Mediterranean (FENAUX, 1968; REGIS, 1978). The gonad indices of individuals living in the beds of C. *nodosa* (whatever the month) are always significantly higher than those of individuals living in the shingle bottoms. This suggests that the urchins living in the C. *nodosa* beds are in a favourable environment perrnitting high gonad production. In constrast, the trophic resources of the shingle biotope constitute a limiting factor. It has been shown that a diet based on the consumption of a preferred vegetable species such as C. *nodosa* promotes high gonad production (FERNANDEZ, 1990). This is comfirmed by the fact that gonad indices in this biotope are generallly higher than those reported in the literature. This is important when considering the dietary regime to be used in urchin rearing. *Cymodocea nodosa* appears to be a choice food which facilitates high gonad growth during the entire year.

Table 1: Average gonad index (GI) of *P. lividus* in the Urbinu lagoon in mg/cm^3, and the percentage of mature females (% mature) in the beds of C. *nodosa*.

	AVR.	MAY	JUNE	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.
GI. C. *nodosa* (1990)	9.76	12.21	9.88	10.64	7.35					
GI Shingle (1990)	3.62	5.70	1.94	0.97	1.62					
GI C. *nodosa* (1991)	8.37	10.06	5.63	7.63	9.33	7.60	5.98	9.05	8.45	9.30
% Mature females (1991)		100	40	25	25	67	50	100	80	75
GI Shingle (1991)		2.01			2.23			5.47		

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Lophogorgia ceratophyta (L.) (Gorgoniidae) in the Bay of Marseilles

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Lophogorgia ceratophyta (Linnaeus, 1768) (Holaxonia, Gorgoniidae) is a large size species (up to 1 m high) (CARPINE, 1963; WEINBERG, 1976) specifically distributed along the French Mediterranean coast. It is found in abundance in the regions of Monaco and Perpignan (WEINBERG, 1976). In between these sites, it is only rarely seen and even appears to be completely absent from Corsican waters (WEINBERG, 1980; F. FINELLI and N. VERNEAU, although it appears on Carpine's recapitulative map of Corsica, at Bastia (1963, p. 53). In one of his earlier works, CARPINE (1963) considers that *L. ceratophyta is* absent from the region of Marseilles. Later on, several colonies are observed near the port of Marseilles by H. Zibrowius and J.G. HARMELIN (*in* CARPINE and GRASSHOFF, 1975; *in* WEINBERG, 1980) or near the port of Madrague (East Marseilles) by J. LABOREL (pers. comm.).

Until 1990, only a few observations of *L. ceratophyta* were made in the Bay of Marseilles and under 10 colonies were found between 25 and 50 meters in depth (pers. obs.; J.G. HARMELIN pers. comm.). Over the past two years, almost 70 colonies have been counted in the Bay of Marseilles, as well as a few others found at La Ciotat or in the Var (Port-Cros and Levant Islands, and Saint-Aygulf). Small size colonies (less than 20 cm high) are the most often observed (61%) and are only found in the North-West part of the Bay of Marseilles, while large size colonies (over 50 cm high) represent 18% of total observations. In this latter case, the colonies had been observed before. Some colonies, remarkable by their localisation, size and depth, have been under observation for several years : over 7 years at Méjean (West Marseilles); over 6 years at Port-Cros (Var); perhaps almost 10 years in Marseilles (Maïre Island). The average size of these colonies was considerable when first observed (over 40 cm high) which tends to prove that they had already been present for several years. *L. ceratophyta* can be observed between 15 and 55 m deep. Small size colonies can be found essentially at over 30 m in 95% of the cases, whereas large colonies are found between 15 and 45 m (91%) of these cases. Most authors (CARPINE, 1963; CARPINE and GRASSHOFF, 1975; WEINBERG, 1976, 1979b) have observed that these colonies are present at the foot of coralligenous falls, on sub-horizontal beds (far from all falls) or near port zones. According to these authors, the waters are very cloudy, and the colonies are usually rooted in sandy and muddy sediments. Most of these colonies are isolated, but, af Méjean, records show a density of approximately 5 colonies/m^2 of *L. ceratophyta* (under 20 cm in height). These figures remain low when compared with observations made by WEINBERG (1976, 1979a) at Banyuls-sur-mer : 12 to 17 colonies/m^2.

According to CARPINE and GRASSHOFF (1975), the epibionts observed for this species only involve *Pteria hirundo*. WEINBERG (1979a) mentioned *Alcyonium coralloïdes*. In 30% of the colonies over 20 cm high, we have observed on the lower thirds of the colony, an Amphiperatidae Gasteropod, *Simnia spelta*, which closely mimics the appearance of the gorgonian. Most often, this species is also found on the *Eunicella singularis* (LAUBIER, 1966; THEODOR, 1967; CARPINE and GRASSHOFF, 1975; SANTANGELO and NAVARRA, 1984) and on *E. cavolinii* (ROSSI, 1965; SANTANGELO and NAVARRA, 1984). Only SANTANGELO and NAVARRA (1984) and WEINBERG (1992) have observed *S. selpta* on *Lophogorgia*. On one *L. ceratophyta* colony under observation since 1986 at Port-Cros (Var), we have noted marked seasonal variations in the quantities of *S. spelta:* gasteropods are present between May and September (up to 6 per colony) and absent, or rarer, during the rest of the year. Reproduction has been observed in May and June. These variations in number correspond to those revealed by SANTANGELO and NAVARRA (1984) on *E. singularis*, in the straits of Messina. The *L. ceratophyta* and *S. spelta* association is therefore frequent and may correspond to that observed by GERHART *et al.*, (1988) between two similar species, *Leptogorgia virgulata* and *Neosimnia uniplicata*. This gorgonian synthesizes secondary anti-fouling metabolites, which limit the number of epibiont species. In spite of these defenses, it is consumed by the symbiotic, trophically specialized gasteropod. Only a few other epibiont species have been observed : a nudibranch *(Flabellina affinis)*, laying its eggs on a medium size colony; seaweed is also rarely seen (in 2% of the cases).

CARPINE and GRASSHOFF (1975) insist upon the difficulty of defining its natural habitat. At Banyuls-sur-mer, it shares the habitat of *Eunicella singularis* (WEINBERG, 1979a). The adult colonies prefer turbid waters or strong currents and *L. ceratophyta* could be a turbidity indicator (CARPINE and GRASSHOFF, 1975). For WEINBERG (1979b), the degree of resistance in adult colonies tends to influence natural distribution more than any other factor. The sudden appearance of small size colonies of *L. ceratophyta* in the Bay of Marseilles seems to demonstrate this assumption and could therefore correspond to the changes in environmental conditions, more favorable now to the development of such colonies than before. It is not at present easy to identify the factors involved. The mean degree of water turbidity has greatly increased in the Bay of Marseilles after industrial or touristic developments (GRAVEZ *et al.*, 1990), but at present, this trend seems to be regressing. The lower mortality rate observed in young colonies could be an indirect result of the increase in average water temperature. We must observe the simultaneous and progressive appearance of *Alicia mirabilis* (Actinaria) which had only previously been seen in the bay of Naples (SCHMIDT, 1972) : Italy, Liguria (Spotorno); France, Alpes-maritimes (Nice), Var (Port-Cros, Les Embiez, Saint-Cyr), Bouches-du-Rhône (La Ciotat, Marseille, Carry-le-Rouet, Sausset-les-Pins). The low reproduction rate of these species and the change in environmental conditions (temperature ?) could explain this progressive appearance from the East (*L. ceratophyta* and *A. mirabilis)* and from the South *(L. ceratophyta)*. An increase in mean turbidity levels over the past years has perhaps caused the development of an important *L. ceratophyta* population. Future evolution of this population must be monitored, if the degree of turbidity continues to decrease, as is the case today.

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The Levantine bathyal - a desert at the bottom of the sea?

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The Levant basin is the easternmost part of the Mediterranean Sea, east of the line connecting Rhodes, Crete and the coast of Cyrenaica. It is isolated from the deep Atlantic waters by the topographical and hydrological barriers posed by the shallow Gibraltar Straits and the Sicilian-Tunisian sill. The Levantine deep waters are distinguished by severe oligotrophy and salinity and temperature values that are higher than in the rest of the Mediterranean.

Investigations of the Levant bathyal biota were initiated with the voyages of the "Pola" one hundred years ago (1890-1893), the most extensive deep-sea expedition to take place in the Levant basin. The Danish Oceanographical Expedition to the Mediterranean, aboard the research steamer "Thor", sampled nine sites along the western limits of the Levant, from Cyrenaica to Rhodes, in 1910. The Lamont Geological Observatory research vessel "Vema" collected plankton samples in July-August of 1956. During a ten-day sojourn in the Levant in January 1987, the "Meteor 5" obtained deep-sea biota from the region between Crete, Cyprus and Israel. The small number of scientific expeditions to the Levant prompted FREDJ and LAUBIER (1985), in their seminal work on the deep Mediterranean benthos, to declare that "the Levant Sea has practically never been studied". The paucity of data bolstered the concept of eastward faunal attenuation: FREDJ and LAUBIER (1985) stated that only 20% of the Mediterranean deep-sea species are known from its eastern part.

A series of eleven cruises conducted between 1988 and 1991 to study the bathyal biota off the coast of Israel brought up a wealth of new data. The 37 species collected at depths between 200-1,530 m add seven new records for the Levant basin and extend the distribution of sixteen more species to the easternmost boundary of the Mediterranean.

As knowledge is gained on the Levantine bathyal biota, and the inventory of its components becomes more complete, so the list of organisms considered absent from the Levantine basin diminishes. Even thus, the impoverishment of the Levantine bathyal fauna is clearly evident. GOREN (1986), who studied the recolonization of the Red Sea at the post glacial period, indicated that the number of fish species in the Red Sea is much lower than in similar Indo-Pacific regions. It is suggested that the Mediterranean, which like the Red Sea underwent severe temperature and salinity changes, has not yet reached its biotic climax. However, these environmental upheavals do not account for the extreme fauna sparsity of the Levant bathyal compared with the bathyal biota at other regions of the Mediterranean.

The Mediterranean received a substantial part of its fauna from the Atlantic Ocean following the last glacial period, bringing into the sea temperate, subtropical and some tropical species. Yet, in the Levant basin, warming of the surface water together with large-volume flooding of fresh and low salinity water caused by deglaciation is considered to have resulted in restricted thermohaline convection, stagnation of subsurface water and deposition of sapropels at water depths greater than 600-1,000 m (VERGNAUD-GRAZZINI *et al.*, 1977; MUERDTER *et al.*, 1984; HERMAN, 1989). Thus, during interglacial periods, the Levantine bathyal underwent faunal extinctions induced by environmental deterioration caused by the anoxic episodes, followed by partial faunistic replenishment in glacial periods. Therefore, we suggest that the impoverishment of the Levantine bathyal fauna results from it being doubly blighted : during glacial periods the prevailing high temperature and salinity prevented settlement by members of the stenothermic and stenohalinic Atlantic bathyal, as far as they were able to cross the Gibraltar and Sicilian sills, while during the postglacial, anoxic conditions in the bathyal restricted its recolonization.

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Polychaetes of the leaf stratum of a *Posidonia oceanica* bed : spatial and seasonal analyses

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In the framework of an investigation on vagile fauna of *Posidonia oceanica* beds (GAMBI *et al.*, 1992), Polychaetes were sampled in the leaf stratum of a continuous *Posidonia* meadow off Lacco Ameno (Island of Ischia, Gulf of Naples, Italy). Samples were taken by SCUBA diving using a hand-towed net (400 µm mesh size); this sampling tool allows the capture of different benthic vagile taxa of the *Posidonia* canopy, although it is not very efficient for Polychaetes (GAMBI *et al.*, in press). Collections were made monthly, from July 1981 to June 1982, along a transect at 1 m, 3 m, 10 m, 15 m and 25 m depths. Each sample consisted in two hand-towed net replicates.

Polychaetes were found in 53 of the 60 samples examined, for a total of 1,811 individuals and 135 species. 38 taxa occurred only once with one individual, while 27 taxa (445 individuals) belonged to sessile, tubicolous forms that will be not considered in the following analysis. The best represented family was that of Syllidae (55 species and 865 individuals). The total number of species and individuals in the different months showed similar trends with two peaks in February-March and from September to November and two minima in July-August and in December-January (Fig. 1). To better define the spatio-temporal distribution pattern of the species, monthly data were grouped in four seasonal groups (summer, autumn, winter and spring) and analyzed by means of the Factorial Analysis of Correspondence (C.A.)

Along the first factorial axis (F1), that was significant, sample points were distributed according to depth (Fig. 2). The highest depth differences were observed in summer and spring. This is because in these seasons several physical conditions (e.g. summer temperature stratification) coupled with *Posidonia* features (leaf growth and plant epiphyte production) enhance the environmental differences between shallow and deep stands of the *Posidonia* beds, thereby resulting in more pronounced differences in the Polychaete populations associated. Seasonal differences in Polychaete community structure were higher between summer-spring and autumn-winter samples especially at shallower depths (from 1 to 10 m) where more fluctuating environmental conditions occur. On the contrary, these were almost negligible in the deepest samples (25 m) where the environment is more stable and less stressed.

The most abundant species, and those that best contribute to such a pattern were *Grubeosyllis clavata, G. limbata, Syllis prolifera, Autolytus sp.1, Platynereis dumerilii, Nereiphylla nana, Raphidrilus nemasoma* and *Oriopsis armandi*, characteristic of shallow depths, and more abundant in summer and spring. *Sphaerosyllis pirifera, Grubeosyllis vieitezi, Pionosyllis lamelligera*, were more frequent at intermediate depth (10 m), while *Eurisyllis tuberculata, Odontosyllis gibba, Exogone rostrata, Sphaerosyllis hystrix, Nereis rava* and *Kefersteinia cirrata* characterized the deeper samples (15-25 m), especially in autumn and winter. *Amphiglena mediterranea* occurred, on the contrary, at all depths and in all seasons.

As a whole, two main Polychaete assemblages seem to be recognizable: one associated to shallow stands of the bed with higher seasonal fluctuations in species composition and abundance; another associated to the deeper, more stable stands of the bed with less changes in time.

With these general trends the spatial and seasonal distribution of Polychaetes in the *Posidonia* leaf stratum is consistent both with the environmental conditions of the bed and with the behaviour of the other groups of the vagile fauna studied (GAMBI *et al.*, 1992).

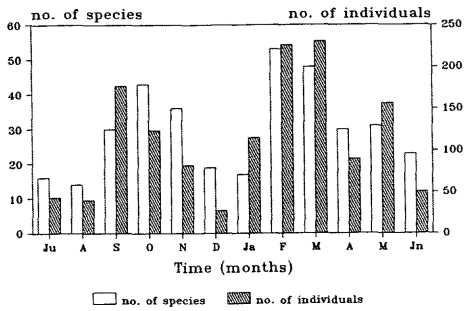

Fig. 1.- Monthly trends of the total number of species and individuals

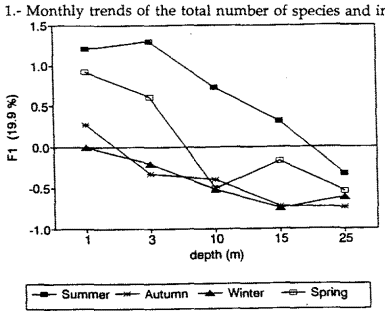

Fig. 2.- C.A. sample-point ordination along first factorail axis (F1)

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Apports chorologiques du Genre *Cystoseira* C. Agardh

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La réalisation du travail "Biosystématique" de l'Ordre des *Fucales* Kylin (Fucophyceae) dans la Péninsule Ibérique et les Iles Baléares", financé par la CICYT (Ministères de l'Education et de la Science du Gouvernement espagnol), fait partie d'un Projet global pour l'élaboration d'une Flore Benthique Marine de cette zone.

Dans l'ensemble des *Fucales* de la Péninsute Ibérique, le genre *Cystoseira* représente le groupe d'espèces le plus nombreux, le plus abondant en Méditerranée et, surtout, le plus intéressant du point de vue taxonomique.

La révision biosystématique de ce genre a été réalisée à partir de matériel frais récolté tout le long des côtes ibériques ainsi que d'échantillons d'herbier. Cet étude a permis, entre autres conclusions, de préciser la chorologie du genre *Cystoseira* le long des côtes ibériques; la distribution de ses espèces en Méditerranée était en effet assez confuse, en raison surtout de la complexité systématique du genre, tout particulièrement au voisinage du détroit de Gibraltar.

B

Les principales conclusions chorologiques sont les suivantes:

- La découverte de *Cystoseira abies-marina* (Gmelin) C. Agardh à Murcia (Espagne) (SOTO & GOMEZ, 1990) confirme sa présence en Méditerranée, où elle n'avait été signalée que de Tripoli (Libye) (NIZAMUDDIN *et al.*, 1978) et du Canal de Sicile (Italie) (AMICO *et al.*, 1985). Ces mêmes auteurs indiquaient la nécessité de confirmer la présence de cette espèce en Méditerranée.
- Des espèces considérées comme de distribution uniquement méditerranéenne ont été localisées dans le détroit de Gibraltar et les zones atlantiques voisines. *C. brachycarpa* J. Agardh var. *balearica* (Sauvageau) Giaccone, largement distribuée dans la Méditerranée centrale et occidentale, est présente jusqu'aux alentours de Tanfa (Cadiz). La présence de *C. sauvageauana* Hamel le long des côtes atlantiques ibériques montre l'influence possible des eaux méditerranéennes dans la zone atlantique proche du détroit, bien que les populations de cette espèce se trouvent dans un milieu caractérisé par la présence de communautés algales typiquement atlantiques. Ces observations confirment la signalisation de cette espèce dans la même zone (CREMADES, 1990) d'après des exemplaires de l'Herbier de Clemente (MA) (sous le nom de *Fucus selaginoides* L.).
- D'autre part, d'autres espèces présentes en Méditerranée occidentale ont été signalées pour la première fois le long des côtes ibériques. Dans ce groupe, on peut inclure *C. jabukae* Ercegovic, récoltée aux Iles Baléares (GOMEZ GARRETA *et al.*, 1992) ainsi qu'un certain nombre de taxons qui se trouvaient déjà sous forme d'échantillons d'herbier (BCF, HGI, MGC, VAB), mais sous un nom erroné tels que *C. barbata* f. *aurantia* (Kutzing) Giaccone, *C. spinosa* var. *compressa* (Ercegovic) Cormaci *et al. C. algeriensis* J. Feldmann et *C. humilis* var. *humilis* Kützing. La distribution de *C. jabukae*, *C. barbata* f. *aurantia* et *C. spinosa* var. *compressa* reste délimitée à la zone comprise entre l'Adriatique et les côtes espagnoles, tandis qu'en Méditerranée, *C. algeriensis* et *C. humilis* var. *humilis* restent localisables dans la zone proche du détroit de Gibraltar (côtes espagnoles), en Algérie et en Sicile, ce qui peut indiquer une certaine relation entre la distribution de ces espaces et la zone d'influence des eaux atlantiques.

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Développement larvaire de *Corallium rubrum* : étude

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L'obtention en laboratoire de larves de *Corallium rubrum* (ponte provoquée et ponte spontanée) a permis de réaliser :

- une étude comparative des conditions de maintien en laboratoire des premiers stades, traitée dans un second travail (CHESSA, GRILLO, PAIS, VITALE, 1992);
- une étude morphologique et ultrastructurale du développement larvaire que nous abordons ici.

Les observations faites à partir de stades juvéniles prélevés périodiquement à Monaco et en Sardaigne ont donné les résultats suivants :

1 - La larve libre de taille comprise entre 1 et 2 mm présente une morphologie commune à celles d' autres Octocoralliaires (WIDERSTEN, 1968) et à de nombreux Hexacoralliaires (BADCOCK et HEYWARD, 1986). Son ectoderme est composé de cellules hautes à gros noyaux (cellules en colonne), de cellules ciliées et de nématocystes. Entre l'ectoderme et une riche réserve lipidique centrale, s'étend une fine bande de mésoglée. D'allure piriforme, la larve développe une invagination de l'ectoderme dans la partie pointue. C'est la future bouche. De façon concomitante, des microvillosités se forment à la surface de l'ectoderme.

2 - Après la fixation, la métamorphose débute immédiatement. La cavité buccale se met en place; la mésoglée s'épaissit; l'ectoderme perd ses cils. La "larve" a pratiquement épuisé toutes ses réserves lipidiques et se nourrit de substances dissoutes à partir du milieu extérieur grâce à ses microvillosités. Les cellules en colonnes au contact du substrat s'aplatissent et deux nouveaux types cellulaires apparaissent dans cette zone :

- des cellules sécrétrices riches en inclusions;
- des cellules dites à plateau, intervenant dans le processus d'adhésion au substrat. Ces cellules sont présentes chez d'autres Octocoralliaires (BOULIGAND, 1968; KINGSLEY et WATABE 1982) ainsi que chez des Hexacoralliaires (WISE, 1970) et des Hydraires (SINGLA, 1976). Dans tous les cas, elles favorisent l'adhésion de tissus à un squelette. Elles présentent la particularité d'être persistantes chez l'adulte de ces espèces alors que chez *Corallium rubrum* elles disparaissent. Entre le substrat et la larve fixée, on note la présence d'une couche de matériel fibreux : du mucus, favorisant lui aussi l'adhésion. Il est sécrété par les cellules basales de la larve au moment de la fixation (GOREAU et HAYES 1977).

3 - Parallèlement à l'ouverture de la bouche, les premiers canaux gastrovasculaires, de nature endodermique, se mettent en place. Reliés à la base du premier polype, ils se ramifient en bordure et débouchent vers l'extérieur par les minuscules "oscules" que l'on retrouve chez la colonie adulte.

4 - Environ 12 jours après l'émission des planulae, les premières formations squelettiques apparaissent : les sclérites. Entourés de leurs scléroblastes, ils forment une couche unique en étroit contact avec l'ectoderme libre. D'abord dépourvus de pigments, ils acquièrent une coloration rouge entre 2 et 3 jours après leur formation.

5 - C'est à ce stade que dans la plupart des cas un deuxième polype apparaît.

6 - Les premiers stades de la formation du squelette axial ont été observés, dans les meilleurs des cas 6 mois, après la naissance des larves. Trois processus de mise en place de l'axe à partir d'un même tissu d'origine: l'ectoderme, ont été mis en évidence :

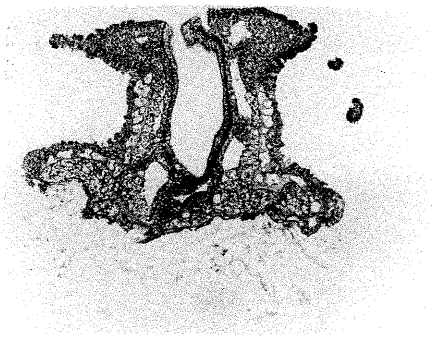
a) conformément à ce qui a été observé chez d'autres Cnidaires (BOULIGAND 1968, VANDERMEULEN, 1975), un début d'axe apparaît entre l'ectoderme du disque basal et le substrat. Cet ectoderme sécréteur correspond à l'épithélium axial de la future colonie, décrit dans un travail antérieur (GRILLO et ALLEMAND 1990; GRILLO, GOLDBERG et ALLEMAND, in prep.);

b) un début de calcification, à l'origine de la formation de l'axe, peut aussi être engendré par la formation de replis ectodermiques. Ces replis apparaissent à la périphérie des individus fixés, tout à fait à la limite entre la partie libre de l'ectoderme et celle fixée au substrat;

c) enfin, au moment de la fixation, il est fréquent d'observer que 2 larves se placent en un même point du substrat, mettant étroitement en contact leur ectoderme. Cette particularité nécessite une histocompatibilité des tissus fréquente chez les larves de Cnidaires (HIDAKA, 1985) et pourrait être à l'origine des colonies hermaphrodites décrites par LACAZE-DUTHIERS (1864). En effet, la zone de contact entre les ectodermes des deux polypes primaires est le site d'un dépôt de carbonate de calcium à l'origine de l'axe central. Ce dépôt est caractérisé par la présence d'une matrice organique dense révélée après décalcification des tissus.

A ce stade, ce tissu ne possède plus que des cellules sécrétrices; les cellules à bord strié dite d'attachement ont disparu.

L'axe commence à croître. Il intègre à son apex les sclérites désormais abondants dans la mésoglée, comme ce sera le cas dans la colonie adulte.



Coupe histologique du premier polype d'une future colonie

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Preliminary results of a checklist of the benthic marine algae of th Greek Coasts (Aegean and Ionian Seas)

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Comprehensive checklist of the North Atlantic marine macroalgae published the last decades were instrumental to the development of the "modern algal biogeography". Such reliable floristic and distributional data are still lacking or insufficient for many regions, e.g. the eastern Mediterranean region (including the greek coasts) (1, 2, 3, 4, 5).

Our Knowledge on the systematic of marine macroalgae of Greece is based on a series of about 50 publications, with the first dated back to the Linnean period ffor literature see 2, 6, 7, 8, 9). Most of these papers has provided valuable floristic, phytosociological and distributional information but very few morphological descriptions. This fact was sometimes a reason for taxonomic confusion that apparently characterized many Mediterranean macroalgae.

GERLOFF and GEISSLER (10) published the first revision of the Greek marine macroalgae while ATHANASIADIS (2) has recently provided an extensive critical review of all previously published records of the marine macroalgae of the Aegean Sea. The present paper aims (a) to critically present a complete checklist of the macroalgae encountered along the greek coasts of the Aegean and Ionian Seas, thus making the best of the two aforementioned as well as of the recent papers dealing with the area, (b) to supply one with the geographical distribution of macroalgae by dividing the greek coasts into three areas, namely the North and the South Aegean, and the Ionian and (c) to establish the degree of floristic similarity between each pair of the three areas, as expressed by Jaccard's similarity-index (11).

In the present study a total of 503 species has been included (313 Rhodophyceae, 103 Phaeophyceae, and Chlorophyceae). The R/P (12) ratio has yielded a value around 3. The paper by GERLOFF and GEISSLER (10) is comprised of 370 species (204 Rhodophyceae, 82 Phaeophyceae and 84 Chlorophyceae) and that by ATHANASIADIS (2) of 433 species (267 Rhodophyceae, 90 Phaeophyceae and 76 Chlorophyceae): the R/P ratios have yielded values around 2.5 and 3, respectively. It is obvious that the increase of the species number included in the present study (133 and 67 more than in the studies by GERLOFF and GEISSLER and ATHANASIADIS respectively) has not brought about drastic differentiations in the R/P values (between 1 = polar and 5 = tropical) which are representatives for the regions with a temperate character. Similar values have been also found in other of the Mediterranean (see 13).

Jaccard's similarity index showed a level of importance above 50% among the North and South Aegean Sea, the North Aegean and Ionian Sea and South Aegean and Ionian Sea. This result has indicated that the Greek Peninsula and the Aegean Islands can not be effective barriers to seaweed dispersal.

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Contribution to biology knowledge of *Laminaria rodriguezii* Bornet

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Laminaria rodriguezii BORNET is an endemic algae of Western Mediterranean. The prostrate branched rhizome of this algae makes the identif ication easy (1). As this plant lives at great depths (2), it has been very difficult to know its geografic distribution (3). Along the last years, however, it has been collected in other localities (4)(5). This same reason has difficulted the research on both physiologic (6) and anatomic (1) characters.

A study on some anatomic characteristics of this species has been carried out on individuals collected in Spanish localities (Menorca, Ibiza, Islas Columbretes and Peniscola; Herbariums BCF, MA, MACB and F. Boisset).

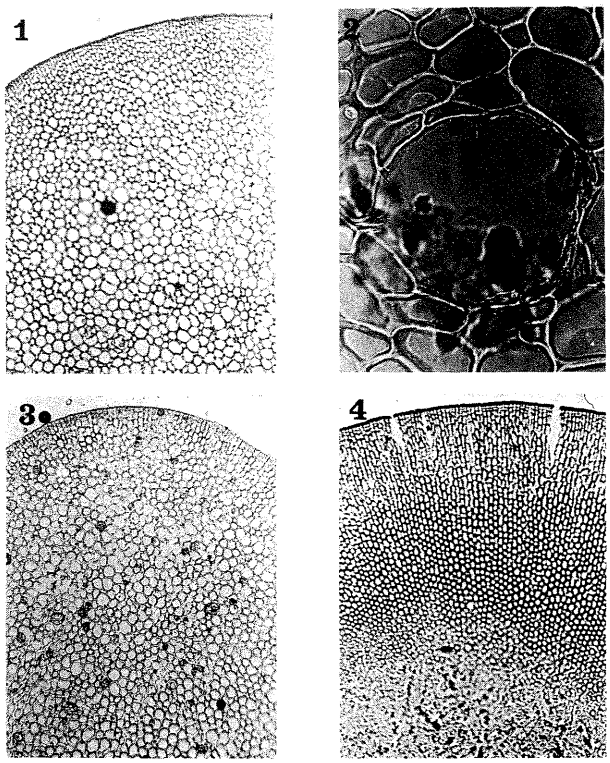
The prostrate branched rhizome consists in a stoloniferous region (4 - 5 µm diameter) where several hapteres (1 - 3 µm diameter) part from. The stoloniferous region is cylindrical and its tranverse section (Fig. 1) shows a two celled layer meristoderm, whose cells are 10 - (15) - 20 µm long and 7 - (10) - 12 µm wide. It presents an outer cuticle of 7 µm wide. A bulky cortex is placed inner. The outer part of it is formed by polygonal cells 18 - (25) - 29 µm long and 13.5 (19.5) - 22 µm wide. Among them, some little mucilage ducts can be seen (Fig. 2) , 70 - 84 µm diameter . As we go inner, polygonal cells are bigger 12- (32) -53 µm diameter .

The hapteres transverse section (Fig. 3) is similar both in composition and cell size to rhizome section. On inner cortex cell end walls we have observed 8 - 12 pits.

Stipe transverse section, 3 - 4 µm diameter, (Fig. 4) shows a 2 - 4 layered meristoderm. This meristoderm is formed by 12 - (16) - 21 µm long, 7 - (10) - 14 µm wide rectangular cells. A bulky outer cuticle, 8 µm wide, appears. The outer cortex is formed by polygonal cells, 17 - (26) - 30 µm long and 8.5 - (13) - 17 µm wide . It lacks of mucilage ducts; the inner cortex is formed by circular cells of 10 - (15) - 24 µm diameter. The medulla is formed by elongated filaments.

In the blade 3 cellular zones can be distinguished : epidermis, one layer of 9 - (9.5) -10.5 µm long and 5 - (6) - 6.5 µm wide cells; cortical zone whose outer cells are more little, 13 - (15.5) -17 µm diameter, than inner cells, 29 - (35) - 40 µm diameter; a thin medulla (70 µm wide) with elongated filaments.

There are significant differences between stipe and rhizome anatomy. On the other hand, the occurrence, diameter, quantity and distribution of *L. rodriguezii* mucilage ducts, as well as cell pit quantity, is different in other laminariales.



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B

B

The effects of the sludge dumping and disposal on the benthic fauna in Izmir Bay

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Izmir Bay is an area which has been subject to efforts to deepen the harbour since 1930. This bay is divided into an inner bay, a middle bay and an outer bay, from the standpoint of topographical and hydrographical characteristics (Fig. 1). The polluted inner bay, where the Izmir harbour is located and where mud-dredging efforts have been carried out, is narrow (57 km2) and shallow (maximum depth 21 m); the unpolluted outer bay, where the mud has been dumped, is much wider (539 km^2 and deeper (45-70 m).

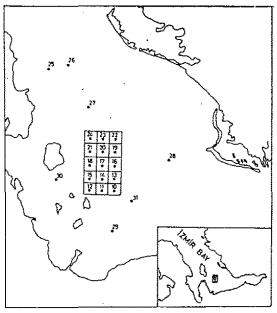

Figure 1. Sampling stations.

Dredging efforts were carried out in the harbour in two periods : 1930-1976 and 1976-1988. In the first period 2.8 million m^3 of mud was dumped back into the inner bay; in the second period 9 million m^3 of mud dredged out was dumped in the outer bay near Hekim Island. In order to determine the effect of the mud dumped in the outer bay upon benthic communities, samples were taken by grab (10 dm^3) from 22 stations which had been decided on in the area in question during June 1990. The results of these samples showed 98 species belonging to 8 groups. Speaking qualitatively, Polychaeta were first with 41 species, followed by Crustacea, with 25 species (Fig. 2).

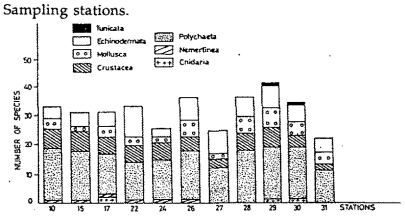

Figure 2. Number of species of different groups found in main 11 stations.

In order to determine the degree of similarity among the 22 stations, when the dendogram made using the BRAY-CURTIS similarity coefficient is examined, the maximal similarity is seen to be 67% (Fig. 3). Of these, the first group, with a similarity of about 56%, was at stations 28 and 29, the second was at station 31, the third group at stations 25 and 26, the fourth group at station 30, and the fifth group, with similarity changed from 45 to 67%, was at the other stations (Fig.4).

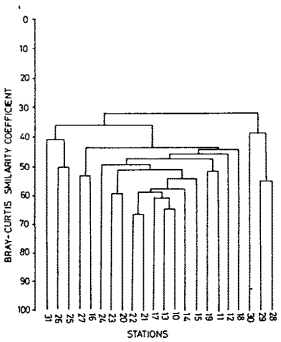

Figure 3. Bray-Curtis similarity dendogram among stations.

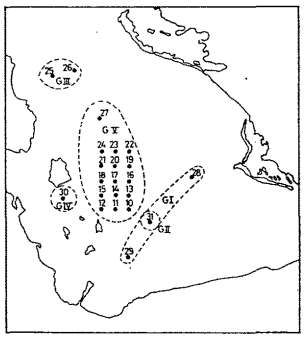

Figure 4. The result of MDS analyses.

In the studies carried out in the dumping area, only *Audouinia tentaculata* of the species characteristic of polluted zones was observed, and a few examples of *Corbula gibba*, characteristic of semi-polluted zones, were observed. In addition, examples of such species as *Brissopsis lyrifera, Labidoplax digitata, Sternaspis scutata* and *Turritella communis* which are characteristic of clean zones, were encountered at all stations. In conclusion, when studies done earlier (GOKCEN and CIRIK, 1988; KOCATAS *et al.*, 1988) are compared with those carried out at stations outside the dumping area, it may be seen that benthic species in this area have not been much affected.

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Seasonal structure and ecological status of Varna Bay (Black Sea) sandy and muddy macrozoobenthic coenoses

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Recently Varna Bay has been considered as an ecologically threatened area mainly due to Varna lake high eutrophic water discharge. According to investigations carried out in 1981 (the season is not mentioned) 5 zoocoenoses are differentiated and 2 new Mollusca species are established (*Mya arenaria* and *Anadara* sp.)(MARINOV *et al.*, 1983). The periodical summer postblooming mass mortality since 1986 has indicated a critical status of macrozoobenthic communities (KONSOULOVA *et al.*,1991). In the present investigations carried out in 1990-1991 period 22 benthic samples have been taken seasonaly from 11 sampling stations (two samples from each station) by a Van Veen grab covering 0.1m2 (Fig.1). The mean data are used for calculating Sorensen's coefficient of similarity, Shannon-Weaver's information index (H) and kombined K-dominance curves for species abundance/biomass comparison detecting the pollution effect on marine macrozoobenthic communities (ABC method)(WARWICK *et al.*,1937).

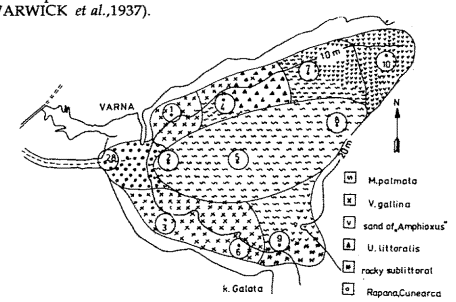

Fig. 1. Sampling stations and zoocoenoses location in Varna Bay

Results

Zoocoenosis Venus gallina (*Chamelea gallina*)(st. 1, 3, 6). From the total of 41 species and groups 20 are Annelida, 12 - Mollusca and 8 - Crustacea. The mean density varies greatly seasonally, the minimum being in spring (596 ind.m^{-2}) and the maximum - in summer (11529). In the structure prevail Annelida-69.6% (*Capitomastus minimus, Polydora ciliata*) followed by Mollusca - 22.1% (*Ch. gallina*), while Crustacea are the least numerous - minimal in summer (3.7%-Balanus improvisus) and greater in autumn (14.15% - *Diogenes pugilator, Ampelisca diadema*). The biomass is almost entirely composed of Mollusca (96.3%) including the new immigrants *Rapana thomasiana* and *Cunearca cornea*. The information index H is the lowest in summer (1.7) and according to ABC graphplots configuration the communities in the sotlthern part of the bay (st.3,6) are "moderately polluted"in this season.

Zoocoenosis Melinna palmata (st.2,5,8). It cover the bottom in the central part of the bay. The total of 44 species are established out of which 15 Annelida, 13 Crustacea and 13 Mollusca. Both the density and structure do not vary greatly seasonally: Annelida are the dominant group (*M. palmata*, Oligochaeta) - average 88.8%, followed by Mollusca *Ch. gallina, Spisula subtruncata*) - 7.0% and Crustacea - 2.6%. The biomass is composed prevailingly of Mollusca dominant species C. *cornea*) - 92.0% It is lowest in autumn (499.6 g.m^{-2}) and highest in spring (1267). The information index H is reduced in summer to minimum 1.8 and in autumn it is increased to maximum 2.2. The manifest dominance of *M. palmata* in summer and the reduction of a number of species in winter determines this zoobenthic community as "moderately polluted" in summer and "grossly polluted" in winter according to the ABC graph-plots configuration.

Zoocoenosis of "Sand of *Amphioxus*" (st. 10). From the total of 61 species 28 are Annelida, 15 - Mollusca and 15 - Crustacea. The mean density varies in a wide range: the minimum is in winter (2390 ind. m^{-2}) and the maximum - in summer (13372). Although Annelida are again the dominant group (*Staurocephalus kefersteinii*) - average 73.0%, in spring and summer they are followed by Mollusca (*Calyptrea chinensis, Mya arenaria*) - 19.5% while in winter and especially in autumn they are followed by Crustacea - 25.2% (*Corophium bonelli, Ampelisca diadema*). The biomass is composed mainly of Mollusca and varies seasonally between minimum 59.0 g.m-Z in autumn and 2364 in spring (*Ch. gallina*). The information index H varies between 2.5 in summer and 3.0 in autumn. According to the kombined K-dominance curves this zoocoenosis is "moderately polluted" in winter. In the rest of the stations macrozoobenthic communities are composed of typical for the neighbouring zoocoenoses species. Dead Crustacea (*U. littoralis, Calianassa pestai* and *Macropipus holsatus*) were registered in the summer postblooming period in 1991 in this area.

The results of comparatively studied two types of zoocoenoses in summer 1990 (in normal disolved oxygen content in the near bottom layers) and 1991 (in the postblooming hypoxia) reveal different responses of the zoobenthic communities. In the *Melinna* zoocoenosis (distingushed by the lowest annual H index - 2.0) information index H goes down from 2.7 in 1990 to 1.9 in 1991, together with a decrease in the total abundance and biomass - 1.4 and 4 times respectively, which determines a trend to a further total reduction of species and specimens. In the zoocoenosis of "Sand of *Amphioxus*" (characterized by the highest H - index) a reaction typical for an earlier stage of pollution is to be observed: the abundance and biomass increase threefold and fourfold respectively in 1991 accompanied by an abrupt drop in the H - index - from 4.1 to 2.15.

Conclusions

1/Summer is the most critical season for the macrozoobenthic communities in Varna bay.

2/The zoocoenoses in the northern part of the bay are in a better ecological status compared to those in the southern part, which in summer are "moderately polluted".

3/In the most unfavourable position is the community in the central part of the bay (muddy bottom) which is "moderately polluted" in summer and "grossly polluted" in winter.

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Macrozoobenthic communities present state in Varna and Beloslav Lakes adjacent to Black Sea

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Beloslav and Varna lakes were fresh - water firths with a little flow into Black sea up to 1909 when after digging a channel between the sea and Varna lake its salinity rose considerably (8 - 13‰). Further there were a number of changes in this lakes as a result of human activity as follows: 1923 - the channel between the two lakes was dug; 1954 - the first plants in the Devnya chemical industrial complex were built: 1968 - "Varna" Thermo - electric power station and its harbour were put into operation; 1974 - "Varna - West" harbour was opened; 1976 the second Varna lake - sea channel was dug. In fact since 1970 the Beloslav lake - Varna lake - Varna bay zone has been an area exposed to the cascade - like west - east influence of anthropogenic factors and the lakes have become a buffer - zone holding pollution back. So they have completely lost their self - purification ability and their salinity is almost the same as that of the sea water (15 - 16‰ at present).

Numerous faunistic and biocoenological investigations in the lakes have been carried out in different periods (VALKANOV, 1935; CASPERS, 1951; KANEVA - ABADJIEVA, 1957; KANEVA - ABADJIEVA *et al.*, 1967). From the last 25-30 years there haven't been data about the benthic zoocoenoses therefore in 1990-91 the present investigations were carried out. From 7 sampling stations in the Beloslav lake and 15 stations in Varna lake were taken samples by Birdge - Ekman grab (0.44 m2)(Fig. 1). The data obtained were used for determining the communities structure, calculating Shannon - Weaver's information index H and kombined K-dominance curves for species abundance/biomass comparison too (ABC method) (WARWICK *et al.*, 1987).

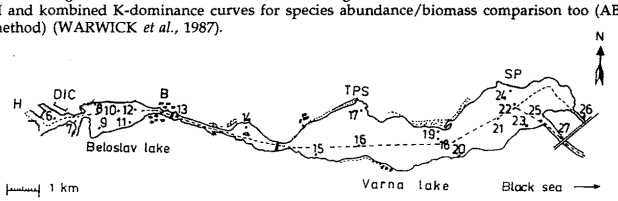

Fig.1. Sampling stations location in Beloslav and Varna lakes
H - "Varna-West" harbour; DIC - Devnya industrial complex;
B - Beloslav town; TPS - "Varna" Termo-electric
power station; SP - Varna town sewage plant.

A total of 7 species and groups are registered in the Beloslav lake, out of which 3 Annelida (*Nereis diversicolor, Melinna palmata, Oligochaeta*), 3 Crustacea (*Gammarus subtypicus, Pontogammarus* sp., *Palaemon elegans*) and *Chironomidae larvae*. The greatest number of species are established in summer (5), while in the rest of the seasons they are 2. The mean density, formed preliminary of *Ch. larvae* (96.8%) is highest in summer (29321 ind.m-2); in spring and winter it is 7155 and 10697 respectively. The mean biomass composed mainly of *Ch. larvae* too (95.5%) is highest in winter (38.8 g.m-2) and lowest in summer (11.52) in accordance with the dominant organisms development cycle specificity. H index (calculable only in two stations - 8 and 12) is extremely low - average 0.05. According to the ABC graph-plots the macrozoobenthic communities are "grossly polluted" in st.8 and "moderately polluted" in st.12 in summer. A typical phenomenon here is the presence of two types of strongly destructed zoocoenoses: 1/totally lacking living organisms - dead zones; 2/ monospecies zoocoenoses. The western part of the lake is a dead zone throughout the year (st.6). It is reduced gradually to east where monospecies coenoses are established in the southern coastal zone and fairway, while along the northern coast a weak trend of improvement of macrozoobenthic communities status is to be observed.

A total of 45 macrozoobenthic species and groups out of which 17 Vermes, 12 Crustacea and 12 Mollusca are registered in the Varna lake. Vermes prevail in density - from 94.0% in winter to 71.2% in summer. The mean density is highest in spring (8449 ind.m-2) composed mainly of *Nereis diversicolo, Nereis succinea, Polydora ciliata* and Oligochaeta and lowest in autumn (2194). Maximum annual density is registered in the almost singular monospecies zoocoenosis situated in the 1st lake sea channel zone (st. 26) - 15658 (*Capitomastus minimus*) and the minimum (88) - in the fairway zone west of the Varna town sewer discharge (st. 22) Vermes prevail in the biomass too (60.4%) excluding the zone in front of and in the second lake - sea channel where Mollusca dominate (67.3%) (*Cunearca cornea, Mytilus galloprovincialis, Rapana thomasiana*). In the last zone the maximum biomass is registered (2272.8 g.m-2) while the minimum biomass zone (0.145) coincides with that of the minimum density.

The information index H varies between 0.55 in autumn to 1.1 in summer. It is lowest (0.25) in the minimum density and biomass area and highest (1.72) - in the second lake - sea channel. There are two dead zones throughout the year in this lake - in front of "Varna" TPS (st. 17) and in front of the town sewage plant (st. 24). In almost all the other stations the H-index is extremely low - from 0.2 to 1.0; the ABC graphplots configuration characterizes some communities as "moderately polluted" and other as "grossly polluted" depending on the season. "Unpolluted" are only two zones - farest from the dead zones (st. 14 and st. 19) whose H - index is 1.6.

Conclusions

1/Most critical is the zoobenthic coenoses status in the Varna and Beloslav lakes in autumn when the dead zones are 8.

2/Totally lacking living macrozoobenthic organisms throughout the year are those areas exposed to industrial and sewage pollution.

3/The presence of "unpolluted" communities in separate limited zones allow us to consider that a certain stabilization and gradual restriction of the zoobenthos is possible after restriction or stopping the pollution.

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Patella caerulea (Gastropoda, Mollusca) as a key biomonitor for chemical and thermal pollution along the rocky intertidal of the Israeli Mediterranean

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Patella caerulea is the most common gastropod in the intertidal and splash zone of the rocky habitats of the Israeli Mediterranean, both natural and artificial. Being microalgal grazers, these organisms are constantly exposed to environmental variables, evolutionarily adapted to survive stress conditions of changing ambient parameters. This makes them suitable for studies of the occurrence of pollutants both in water as well as the atmosphere. This study was performed during 1989-1991 along various sites of the Mediterranean shore with special attention to locations occupied by electric power plants using coals, where the cooling heated-up water outflowed onto the rocky shore. Monthly samples were analyzed for heavy metals by flameless NAS for mercury, and by AAS and X-ray probe for other metals. The ecology of the population was studied on marked quadrants, and gonadial activity and GI were examined by serial histological sections.

Table 1 summarizes the results of metals in *Patella* at the sites from Rosh Hanikra on the Lebanese border to Ashdod in the south. Although raised levels of heavy metals were revealed at several sites, the detrimental synergism of pollution and higher water temperature, such as found at Hadera, (the site of the power plant), is evident, especially concerning mercury, zinc, iron and cadmium. This site also demonstrated very high levels of sulphur, chlorine and magnesium. Figure 1 shows the levels of cadmium, copper and lead in two consecutive years, 1989-1990. As evident, on most sites close to the industrial zones an increase in these metals was observed.

Table 1: Metal concentrations in *Patella caerulea* collected along the Mediterranean Sea of Israel: Maximal (µg/g/dry weight) from north to south of the country .

Site	Cd	Cu	Pb	Fe	Hg	Zn
Rosh Hanikra	3.67	7.19	5.53	1505.1	0.0	72.15
Akhziv	5.26	12.75	8.4447	1650.5	0.052	94.78
Akko	5.92	18.37	9.73	1345.8	0.013	94.72
Atlit	3.25	7.81	10.5	1388.3	0.0	75.58
Caesarea	2.10	10.18	9.22	1501.3	0.0	89.86
Hadera (EPP)	4.76	21.00	8.52	3468.0	0.225	219.40
Mikhmoret	2.80	12.82	6.02	1863.4	0.0	83.47
Sidni Ali	1.04	9.10	10.42	1468.2	0.0	53.89
Tel Aviv	2.07	25.12	13.68	2669.9	0.0	95.64
Bat Yam	2.32	11.97	8.80	1526.1	0.0	69.50
Palmahim	4.42	7.65	5.73	1351.8	0.056	65.10
Ashdod	4.18	17.52	10.31	1852.9	0.0	66.10

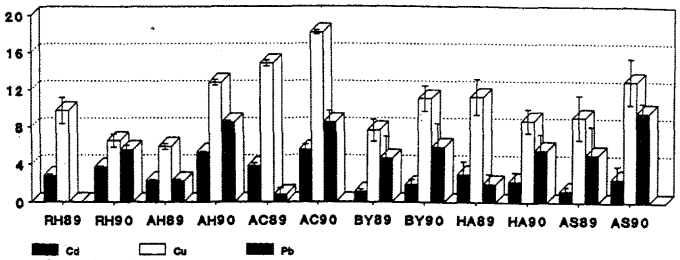
Table 2 compares the levels of three metals as reported from various sites of the Mediterranean. The Israeli material has almost the highest level of pollution.

In *P. caerulea* the levels of metal concentrations of anthropogenic origin demonstrated correlation with the proximity to power plants, both near Hadera (north of Tel Aviv) and near Ashdod (south of Tel Aviv) (Fig. 1). As these sites are in the centre of industrial areas, particularly metallurgic and chemical, we cannot isolate individual polluters, but should see the results as consequences of a possible synergism of all biological active agents.

Table 2: Metal concentration in *Patella* spp. (µg/g/dry weight) from various shores of the Mediterranean Sea (CASTAGNA *et al.*, 1985; RAMELOW, 1985)

Location	Cu	Cd	Pb
Turkey (1985)	3.5-13.7	2.1-40.3	0.3-3.2
Sicily (1985)	6.12-29.3	1.52-6.72	2.34-45.3
Spain (1978)	5.0-10.0	1.1-7.1	2.0-16.0
Lebanon (1978)	11.3-38.0	0.4-4.7	6.8-95.6
Israel (1990)	6.5-46.7	0.5-11.3	0.42-25.9

Figure 1 : Selected metals in *P. Caerulea* (µg/g/dry weight) from along the Israeli Mediterranean, in 1989-1990; RH - Rosh Hanikra; AH -Akhziv; AC - Akko; HA Hadera; BY - Bat Yam; AS - Ashdod.



The ecological observations revealed that during summer, at the site of the electric power plant, water temperature in the proximity rises 10-11°C above the normal, reaching 41°C. This eliminates the local population of *Patella* and re-settling occurs during the autumn as water temperature drops back to 22-23°C. Histological observations showed that at such hot points the gonads undergo degenerative processes, leading towards reabsorption of ripening eggs, multiplication of primary oogoni, and hermaphroditism, especially masculinization. Enzyme analysis revealed that at these sites the Cytochrome P-450 showed very low levels. It can be predicted that if such hotwater outflows multiply along the shoreline, the entire population of *Patella* and other intertidal organisms will undergo a process of dramatic change.

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Modes de dissémination de l'algue *Caulerpa taxifolia* introduite en Méditerranée

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L'algue tropicale *Caulerpa taxifolia* (Vahl) C. Agardh, observée la première fois en 1984 sous le Musée Océanographique de Monaco, n'avait jamais été signalée en Méditerranée. Cette Ulvophycée était cultivée depuis le début des années 1980 dans les aquariums de ce Musée: elle a très vraisemblablement été introduite accidentellement à partir de cette source. Depuis son extension inquiétante a été suivie (MEINESZ et HESSE, 1991; MEINESZ *et al.*, 1992). Cette espèce, qui n'a jamais constitué d'étendues importantes dans les mers tropicales (peu fréquente dans les mers tropicales et rare en Mer Rouge où elle n'a été signalée la première fois qu'en 1974), couvre maintenant, sur la Côte d'Azur, de larges étendues monospécifiques sur tous les types de substrats de 0 jusqu'à 50 m de profondeur devant les sites exposés (caps) ou les baies abritées et elle s'accomode des eaux polluées des ports. Entrant en concurrence et éliminant la plupart des espèces végétales de l'étage infralittoral, cette algue représente une menace pour tous les écosystèmes littoraux de la Méditerranée. Les modes de dissémination de cette espèce doivent être analysés pour tenter d'enrayer ou de freiner son extension. Après deux années de suivi et de cartographie des zones colonisées, nous pouvons distinguer deux voies de dissémination: - les voies naturelles: reproduction sexuée avec dissémination par les courants, ou végétative avec dissémination par reptation, par les courants ou par des organismes marins; - les voies anthropiques (ancres des bateaux, filets des pêcheurs et rejets par des aquariums). La reproduction végétative peut adopter deux modes différents: - la croissance et la ramification des stolons: ces axes rampants se développent de mai à novembre et peuvent pousser jusqu'à 5 cm par jour; cette croissance apicale s'accompagne d'une nécrose aussi rapide de la partie distale. En zone périphérique d'un territoire colonisé, ce stolon est très ramifié: 10 ramifications ont été comptées sur un individu. Lorsque la nécrose atteint une ramification, l'individu s'est multiplié. Dans les zones de forte densité (jusqu'à 244 m de stolon par m^2), les stolons sont peu ou pas ramifiés: l'espèce semble ainsi réguler le taux de ramification en fonction de sa densité. Ce mode de reproduction végétative permet une progression annuelle de l'algue de 2 à 3 m par an au maximum, à partir d'un point de colonisation.

- la fragmentation du thalle par l'hydrodynamisme: après les grosses tempêtes de nombreux fragments de frondes ou des parties plus importantes du thalle ont été souvent rencontrées. La flottabilité de ces fragments est négative et ils sont donc entraînés vers de plus grandes profondeurs. Chaque fragment peut régénérer un thalle entier. Nous avons par exemple, obtenu en aquarium à 18°C cinq stolons à partir d'un fragment de 10 cm d'une fronde. Les récoltes fréquentes de fragments de *Caulerpa taxifolia* entre 100 et 300 m de profondeur dans les filets de pêcheurs entre Menton et Saint Jean Cap Ferrat pourraient être expliqués par cette manière (fragments en épave). Cette reproduction favorise l'extension de l'algue de la surface vers les plus grandes profondeurs au droit des zones colonisées. Les courants peuvent également véhiculer les fragments latéralement, mais leur progression sur le fond est le plus souvent stoppée par les multiples obstacles rencontrés (roches, algues, Phanérogames) qui favorisent leur fixation. Cette fragmentation peut être aussi induite par certaines espèces d'invertébrés. Deux oursins peuvent "transporter" des fragments de l'algue sur leur partie apicale: *Sphaerochinus granularis Paracentrotus lividus* de même que la petite araignée de mer *Maja verrucosa*. Ces trois espèces ont été parfois trouvées portant des fragments de *C. taxifolia* (Cap Martin). En aquarium lorsqu'on dispose ces espèces en présence de fragments de thalle de *C. taxifolia* ils les disposent sur leur partie apicale (oursins) ou sur leur céphalothorax (araignée) en moins de 24 heures. Ces espèces peuvent ainsi véhiculer des fragments de *Caulerpa* plusieurs dizaines de mètres autour des zones colonisées. La reproduction sexuée a été observée le 28 juillet 1992 au Cap Martin. Nous avions déjà suspecté (MEINESZ et HESSE, 1991) cette voie de reproduction d'être responsable de la dissémination à longue portée de l'algue qui a été observée notamment à 60 km (Agay), 110 km (Lavandou) et 150 km (Toulon) des zones très touchées dans le sens du courant ligure. Les thalles en reproduction présentaient de nombreuses papilles permettant l'évacuation des gamètes et nous avons pu observer des gamètes flagellés. Bien que nous n'ayons pas encore identifié les deux types de gamètes et les zygotes, cette voie de reproduction expliquerait d'une part la présence de l'algue dans des sites très éloignés où ils se déposent d'une façon très aléatoire, et d'autre part la configuration des apparitions de nouvelles colonies très nombreuses l'année suivant la colonisation d'une zone. Les multiples points de colonisation et leur situation (profondeur et biotope) au voisinage des zones entièrement couvertes au Cap Martin ne peuvent être expliqués par les modes de dissémination végétative. Au Cap Martin et à Roquebrune Cap Martin la progression latérale à partir d'une zone colonisée a atteint 300 mètres de 1991 à 1992 avec plusieurs dizaines de nouveaux points de colonisation situés sur le même niveau bathymétrique. Ces observations permettent pour la première fois de comprendre la particularité remarquable des Caulerpales, qui présentent un stade protosphère après la formation du zygote. Celui-ci évolue en six mois avant de donner un stade juvénile qui évolue à son tour en une plante adulte. Chez les autres algues les premiers stades de développement du zygote donnent soit des filaments (protonema) qui se fixent sur le substrat soit des colonisations discoides. La protosphère serait ainsi un caractère évolutif des Caulerpales adapté à la dissémination. Une partie de la production des protosphères serait pélagique et donc susceptible d'atteindre d'une façon aléatoire les côtes au gré des courants. La direction et la force des courants les rares jours d'été où l'algue se reproduit, et la densité et surface occupée par le peuplement à Caulerpa (augmentant le nombre d'individus en reproduction) conditionnent la reproduction par cette voie sur de longues distances.

Trois modes de dissémination anthropique sont également suspectés dans certains cas:

- par des filets de pêcheurs: les pêcheurs qui calent leurs filets à proximité du Cap Martin, zone particulièrement touchée par l'invasion, ramènent chaque fois des fragments de *C. taxifolia* au port. Les filets sont nettoyés dans le vieux port de Menton et *C. taxifolia* s'y est implantée depuis 1990 ou 1991 et développée pour former en novembre 1991 un peuplement de près de 100 m2 localisé sous les barques de pêcheurs.

- par d'autres aquariums: en janvier 1992 nous avons été amenés à expertiser un nouveau site à 180 km de Monaco, l'algue a été observée sous les quais d'un port (Les Lecques département du Var). LABOREL (1992) a examiné le substrat sur lesquel l'algue était fixé: il a constaté qu'il s'agissait de coraux morts tropicaux très érodés du genre *Porites*. Ainsi l'origine de cette nouvelle colonie est, comme pour celle de Monaco, très vraisemblablement due à un rejet du contenu d'un aquarium. Uniquement connue dans les circuits des grands aquariums publics au début des années 1980, un commerce de l'algue *C. taxifolia* appréciée pour décorer les aquariums tropicaux, s'est organisé depuis 1990, date où l'existence de grandes surfaces de l'algue a été révélée sur la côte d'azur. Depuis elle est en vente dans tous les commerces de vente d'espèces tropicales pour aquariums ce qui a sensiblement augmenté les risques de contamination secondaire par cette voie.

- par les ancres de bateaux de plaisance: en mouillant sur le mouillage forain du Cap Martin il est difficile de ne pas ramener des fragments de *Caulerpa taxifolia* sur la chaîne et sur l'ancre. Si le bateau mouille de l'ancre dans un autre site (ou nettoie son ancre), il y a de grandes probabilités de contamination. Cette voie de dissémination est suspectée à Agay (dans un petit port privé) et à Saint Cyprien (Pyrénées orientales: 350 km de Monaco) bien que la reproduction sexuée ou le rejet du contenu d'un aquarium peuvent dans ces cas également être mis en cause. S'il est possible de limiter la dissémination anthropique (interdiction de vente de transport et de détention de cette algue, interdiction de mouillage ou de pêche dans des zones colonisées) l'extension de l'algue par voie naturelle tend vers une extension exponentielle. Ainsi on ne peut espérer limiter longtemps la colonisation dans un secteur donné car plus les surfaces sont importantes, plus la probabilité d'une reproduction sexuée et des colonisations répétées et sera plus élevée à la périphérie des zones colonisées.

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Remarks on some deep-water Ostracode species in the Levantine Basin

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Deep-water ostracode faunae are normally characterized by a low specific diversity. In addition, deep water eastern Mediterranean fauna greatly differs from that of the western Basin, since it is characterized by a still more reduced number of species (BONADUCE *et al.*, 1983; VAN HARTEN, 1987; VAN HARTEN & DROSTE, 1988). This can be explained with particular physical-oceanographic conditions, which were responsible of extended anoxic phases in the eastern Mediterranean sea during Plio-Quaternary. Such conditions originated deposits with very high organic matter content (sapropels and sapropelitic layers). Ostracodes, which are particularly sensitive to environmental changes, result widely affected by these conditions (VAN HARTEN, 1987; VAN HARTEN & DROSTE, 1988).

The Geological and Paleontological Institute of the Trieste University organized two oceanographic cruises (1986 and 1987) on Cyprus Basin (coordinator prof. A. Brambati). In these occasions three cores have been recovered (fig. 1).

The sequences studied chiefly indicate pelitic sediments with irregularly interbedded coarser ones. Moreover sapropel layers (organic carbon > 2%, *sensu* KIDD *et al.*, 1978), sapropelitic layers (organic carbon 0.5 - 2 %, *sensu* KIDD *et al.*, 1978) together with one tephra layer have been identified. They are interbedded to from beige to light-dark grey pelitic sediments. These layers are particularly useful to date the studied core-sequences and to correlate the corresponding environmental events in the basin.

The micropaleontological analyses mainly highlight the ostracode faunae which occur in these cores. The composition of the ostracode association seems to be linked to a core-interval which is included between two sapropel layers. This short article focuses on the composition of the ostracodes within such core-interval. Fig. 2 summarizes the data of the core Medo 4 and highlights partially those derived by the analyses between S2 and Sl sapropels (from bottom to top) :

- sapropel S2 : no ostracode fauna;
- above sapropel S2 : occurrence of *Argilloecia acuminata*, *Bythocypris bosquetiana* and *Polycope* sp. pl.;
- between S2 and S1 : increasing specific diversity; other species appear (*Argilloecia* sp. pl., *Bathycythere vanstraateni*, *Bythocypris bosquetiana*, *Cytheropteron* sp. pl., *Krithe* aff. *Praetexta*, *Paracytherois* sp. pl., *Pedicythere Phryne*, *Polycope* sp. pl., *Pontocypris acuminata*, *Pseudocythere* sp. pl. and *Tuberculocythere tetrapteron*);
- before sapropel S1 : reduced specific diversity (*Polycope* sp. pl.);
- sapropel S1 : no ostracode fauna.

This trend of the ostracode fauna composition also occurs on the other cores-interval (sapropel-pelite-sapropel) of all the cores. In conclusion it is possible to recognise the following trend within the dynamics of the ostracode fauna:

a) no ostracode fauna during anoxic phases;

b) colonization due to specimens of *Argilloecia acuminata*, *Bythocypris bosquetiana* and *Polycope* sp.pl.) immediately after the anoxic phases;

c) following high specificy diversity corresponding to the diversification and stabilisation phases;

c) reduction of the specific diversity (*Argilloecia acuminata*, *Bythocypris bosquetiana* and *Polycope* sp. pl.) immediately before following anoxic phase, which is devoid of benthic fauna. Moreover, in the actual layers is also present rare specimens of *Bathycyhtere vanstrateeni*, generally not found in the actual sediments.

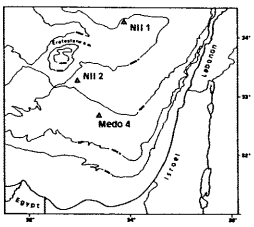

Fig. 1.- Core location in the Cyprus Basin

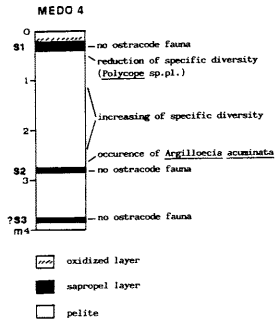

Fig. 2.- Core Medo 4: trend of ostracode association

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Impact d'une pollution industrielle sur des peuplements superficiels des côtes rocheuses du Maroc

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La région d' El Jadida 33° 4' 3"-33°15'38"N, 8°31'06" - 8° 40'12"W)) comporte un gisement important et naturel d'algues marines benthiques à grand intérêt économique. Ces algues abritent une faune très riche et diversifiée. A 25 kilomètres au Sud-Ouest de la ville d'El Jadida, se situe le secteur industriel de Jorf Lasfar (33°05'32"-33°06'12"N, 8°39'05" - 8° 39' 18"W) où a été construit un port, du même nom, et où débouchent les deux effluents de l'usine Maroc-chimie : un émissaire principal et un effluent secondaire ; ce dernier parait assurer uniquement l'évacuation, vers la mer, d'eaux de refroidissement.

L'analyse des eaux au niveau de l'émissaire principal (BERDAY, 1989) a montré qu'elles sont très acides (PH = 1,5), très riche en phosphore (1483,39 mg/l), en calcium (3248 mg/l) et en d'autres éléments chimiques. Il s'agit donc d'un site très pollué que nous avons pris comme exemple pour mettre en évidence l'impact d'une pollution industrielle sur la structure des peuplements benthiques des substrats rocheux.

A proximité de l'émissaire principal (St.E), le substrat est complètement brûlé, noirâtre et parfaitement azoique. Ce n'est qu'à une centaine de mètres au Nord-Est de l'égoût qu'apparaissent des entéromorphes, caractéristiques des milieux pollués. Cependant, même si le taux de recouvrement du substrat est relativement élevé, ce peuplement algal demeure parfaitement azoique et d'entre plus de 200 espèces animales benthiques pouvant être déterminées dans ce secteur, aucune n'arrive à s'y installer.

La première espèce (*Doris* sp : mollusque opisthobranche) n'apparait qu'à 300 mètres environ au Nord-Est de l'égoût (St. Ec); soit entre les filaments des enteromorphes, soit adhérant directement au substrat à la manière des *Melaraphe* qu'elle parait d'ailleurs remplacer, dans les zones polluées, aux niveaux des étages supralittoral et médiolittoral.

A 2 km environ de la source de la pollution (St. A) et dans les étages supralittoral et médiolittoral apparaissent quelques espèces appartenant aux genres *Melaraphe, Monodonta, Gibbula* et *Patella*. Dans l'étage infralittoral, un seul peuplement a pu être identifié : Celui a *Ulva rigida*, également caractéristique des milieux pollués. Ce peuplement abrite une faune, très fréquente dans ce type de milieux, et dans celui des flaques résiduelles (MENIOUI, 1988), mais qui reste très pauvre en espèces et en individus ; il s'agit, entre autres, de *Hyale perrieri, Melita palmata, Perinereis cultrifera,...*

A 4 Km environ de cet égoût (St . R), les espèces des étages supralittoral et médiolittoral restent les mêmes mais sont beaucoup plus abondantes ; alors que la structure et la physionomie du peuplement infralittoral subit un changement radical : l'espèce dominante est l'algue *Gigartina* sp. abritant une faune diversifiée, constituée d'espèces dont *Hyale schmidti* et *Jassa falcata*, deux espèces considérées comme caractéristiques des eaux pures (MENIOUI *et al* ., 1990).

A 7 Km environ de l'égoût (St. SA), dans une plage fortement battue par les vagues et comportant une petite avancée rocheuse, les faciès sont encore plus diversifiés. Mais, il importe de signaler que même si le peuplement algal comporte des espèces d' eau pure tel que celui à *Cystoseira ericoides*, la structure de la faune qu'il abrite parait très altérée et ne ressemble en rien à celle vivant dans le même faciès dans d'autres secteurs plus propres de la côte atlantique du Maroc. Dans ce secteur, le peuplement animal ne parait vraiment bien établi qu'à une quinzaine de kilomètres.

Le traitement de ces données (y cornprises des données provenant de stations étudiées très loin du secteur mais à la même période) par l'Analyse Factorielle des Correspondances a permis de mettre en évidence la particularité bionomique du secteur de Jorf Lasfar dont les stations sont soit parfaitement azoiques, soit extrêmement pauvres en espèces et en individus. Dans cette Analyse, les stations proches de l émissaire principal se caractérisent toutes par des espèces indicatrices de pollution (traitement ne figurant pas dans ce condensé).

L'analyse de l'étude écologique de la flore algale de Jorf Lasfar (BERDAY, 1989), nous conduit aux mêmes déductions. Ainsi parmi 143 espèces ayant été identifiées dans le secteur, aucune n'arrive à "pousser" à proximité immédiate de l'égoût ; une seule espèce, caractéristique des eaux polluées, a été recensée à une cinquantaine de mètres, deux espèces, également caractéristiques des milieux pollués, ont pu être identifiées à une centaine de mètres et 27 espèces, seulement à plus de 2,5 km de la source de pollution. Le peuplement algal ne commence à bien se reconstituer qu'a 5 Km environ de l'émissaire principal.

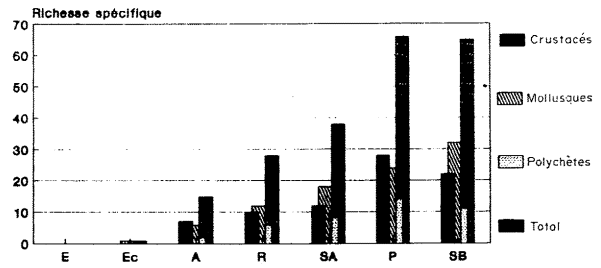

Fig. 1 : Structure de la faune en fonction de la distance à la source de pollution

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Interpénétration entre les faunes Atlantique et Méditerranéenne à travers le détroit de Gibraltar (Faune benthique superficielle)

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L'analyse biogéographique de 336 espèces (Crustacés, Mollusques et Polychètes), recensées sur les côtes marocaines (fig.1) a permis de mettre en évidence que la faune benthique superficielle des substrats durs, c'est à dire la faune benthique infralittorale superieure est essentiellement dominée par des formes à répartitions lusitanienne et boréo-lusitanienne qui, dans leur ensemble, constituent plus de 57% du total des espèces (fig. 2). Les formes à large répartition géographique sont relativement bien représentées, constituant près de 35% du total des espèces. L'analyse de la dispersion des formes strictement lusitaniennes (111 espèces) montre que 36%, seulement, sont connues des trois régions méditerranéenne, marocaine et ibéro-française. Les espèces limitées aux deux premières régions (47%) sont beaucoup plus nombreuses que celles connues uniquement des deux régions méditerranéenne et ibéro-française (3%).

Les espèces "endémiques" de la Méditerranée sont relativement peu représentées (16 espèces, soit 4,7% du total de la faune). Parmi ces espèces, 14 sont des crustacés, soit des ostracodes très peu étudiés dans cette zone, soit encore des espèces rares ou récemment décrites dont l'aire de dispersion reste, par conséquent, encore mal connue. Il en resulte que les données concernant ces espèces "endémiques" sont trop peu nombreuses et fragmentaires pour pouvoir confirmer, avec certitude, leur endémisme méditerranéen. Mais, il importe de signaler que plusieurs crustacés qui étaient considérés comme endémiques de la Méditerranée, ont récemment été récoltés en Atlantique, toujours plus dispersés dans la région marocaine que dans la région ibéro-française (ALMACA, 1985, MENIOUI et RUFFO, 1989). Ceci laisse logiquement supposer que d'autres espèces, toujours considérées comme endémiques de la Méditerranée, ont très probablement une dispersion plus large.

De l'ensemble de ces données, il découle que le détroit de Gibraltar ne constitue pas une véritable barrière biogéographique vis à vis de la faune superficielle et que l'interpénétration faunistique entre l'Est et l'Ouest de ce détroit est pratiquement totale (MENIOUI, 1991). Il en découle également que la faune "méditerranéenne" montre plus d'affinités avec celle de la façade atlantique du Maroc qu'avec celle de la péninsule ibérique et que les échanges faunistiques de la Méditerranée se font plus facilement avec la région marocaine qu'avec la région ibéro-française. En effet, de nombreux auteurs s'accordent pour considérer l'Atlantique comme le réservoir où la Méditerranée puise l'essentiel de sa faune, ce qui est dû à plusieurs facteurs historiques et environnementaux : la crise méssinienne a tout d'abord entraîné l'anéantissement de la majorité de la faune paléoméditerranéenne ; puis dès le pliocène, la Méditerranée a été repeuplée par l'élément atlantique dont la structure est restée pratiquement constante. Actuellement, la Méditerranée se comporte comme un bassin de concentration, d'où un appel d'eau atlantique superficielle vers l'Est. Quant aux eaux méditerranéennes, elles sont entraînées dans un mouvement plongeant vers l'Atlantique ; elles sont, par la suite, véhiculées vers la surface par des courants verticaux et peuvent être identifiées jusqu'à Cap Blanc. D'autre part, à côté des flux superficiels permanents, qui alimentent la Méditerranée, existe un courant plus faible qui, périodiquement, franchit le détroit vers l'Ouest. Ainsi, si le "transport" des espèces vers la Méditerranée peut être en partie expliqué par le flux superficiel entrant, la présence d'espèces "méditerranéennes" en Atlantique peut être expliquée par les phénomènes d'upwelling, qui font remonter vers la surface, des eaux et des espèces méditerranéennes ; mais aussi par les faibles courants superficiels qui, périodiquement, traversent le détroit de Gibraltar vers l'Ouest.

Des résultats de certains travaux tels que COSTE et al, 1986, il découle que la température, relativement constante le long des côtes marocaines, subit, à partir des côtes sud-portugaises une importante diminution due à des upwellings, plus intenses au niveau du Cap Sines, et qui empêcherait probablement la diffusion, vers le Nord, d'espèces méditerranéennes. Ceci expliquerait, peut-être, pourquoi les échanges se font plus facilement entre les régions marocaines et méditerranéennes qu'entre cette dernière et la région ibéro-française.

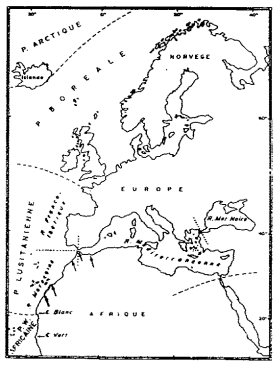

Fig. 1 : Carte des Provinces (P) et des Régions (R) de l'Atlantique Nord-Est — Stations de prélèvements (—)

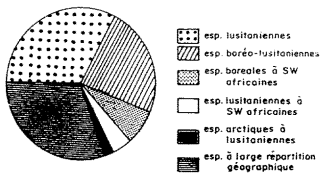

Fig. 2 : Spectre biogéographique de la faune benthique .

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B

Stomach content analysis of Norway Lobster, *Nephrops norvegicus*, in the North Aegean Sea (Greece)

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Introduction

Norway lobster (*Nephrops norvegicus*) is a species of high commercial importance. Published information on its food habits are limited (Atlantic and West Mediterranean Sea: THOMAS & DAVIDSON, 1962; FARMER, 1975; SARDA & VALLADARES, 1989). A preliminary study on the biology of the species is available from the Greek seas (MYTILINEOU *et al.*, 1990), but no information exists concerning its diet. This work is a preliminary study on the food habits of the norway lobster from the North Aegean sea.

Material and methods

A total of 1365 individuals (689 females, 676 males) was collected seasonally, between June 1990 and March 1991, by a fishing trawler with a cod-end mesh size of 28mm (streched), in the North Aegean Sea. Carapace length (CL), weight, sex and maturity stages were recorded in the laboratory. Stomach contents were exctracted, weighed and analysed Prey organisms were identified to the lowest possible taxon. The mean individual degree of fullness (LEBEDEV, 1946), the mean individual index of fullness (HUREAU, 1966) and the percentage of empty stomachs were estimated. The importance of different prey types in the diet was expressed as percent frequency of occurrence (%F) (HYSLOP, 1980) and its relationship with length and sex was examined.

Results

Carapace length of norway lobsters taken for food analysis, ranged from 16 to 61mm and from 15 to 48mm for males and females respectively. Over all, 159 stomachs for males and 248 for females were empty. The percentage of empty stomachs was estimated seasonally and was found higher in September and December (Table I). Females had higher percentage than males, especially in September. The mean individual degree and index of fullness were higher in March and June (Table I).

TABLE I. Seasonal fluctuations of the feeding intensity of Norway lobster in the North Aegean Sea.

MALES	June	Sept.	Dec.	March
Stomachs examined	286	145	143	102
Empty stomachs (0/0)	16.1	24.8	41.3	17.7
Fullness index (0/00)	61.1	56.1	34.9	61.6
Fullness degree	2.45	2.25	2.07	2.73
FEMALES	**June**	**Sept.**	**Dec.**	**March**
Stomachs examined	316	124	125	124
Empty stomachs (0/0)	26.0	57.3	55.2	21.0
Fullness index (0/00)	66.9	30.3	30.8	69.6
Fullness degree	2.04	1.96	1.56	2.70

The examination of the degree of fullness in relation to maturity stage showed that berried females presented very low values (September: 0.53 and December: 0.67).

Stomach contents consisted mainly of particles of crustaceans, fish vertebrae and otoliths, parts of muscles and other organic items, difficult to be identified. Ten taxa, including the digested food and the unidentified organisms, were considered in the graphical representation of the qualitative analysis of the diet (Fig.1). Digested food showed the higher F value (~65%) in the diet of Norway lobster, followed by decapods and other crustaceans (~40%), fish (~15%) and cephalopods (~10%). There was little seasonal variation in the diet; decapods and cephalopods were more frequent in winter, while other crustaceans and fish in autumn and spring. No differences were found in the diet between sexes. However, more taxa (polychaets, foraminifera and unidentified organisms) were identified in the diet of males than females (Fig.1).

The F values of the different taxa showed differences with size. The stomach contents of the young norway lobsters (<20mm CL) contained almost exclusively digested food (80%); decapods, gastropods and cephalopods were also found in the diet of young males, whereas only crustaceans in the diet of young females. The F value of decapods and other crustaceans appeared to increase with increasing length (CL), whereas the F of fish was higher for specimens with CL>40mm.

Discussion and conclusions

The feeding intensity of norway lobster in the North Aegean Sea was low. The maximum intensity appeared in spring and summer while the minimum in autumn and winter. Berried females showed a high percentage of empty stomachs, as FARMER (1975) has also reported. Food items were difficult to be identified. Digested food presented high F values, possibly related to the low ability of the species to ingest large particles of food (THOMAS & DAVIDSON, 1962). Decapods and other crustaceans comprised mainly the food of Norway lobster, followed by fish and cephalopds. However, if the relative digestion rate of the different prey types consumed (polychaets, crustaceans, gastropods etc) had been taken into consideration, a different food composition might be found. Little variation appeared in the diet composition between seasons and sexes. Food of young individuals consisted mainly of detritus and small organic fragments, while adults fed with larger items of crustaceans and fish.

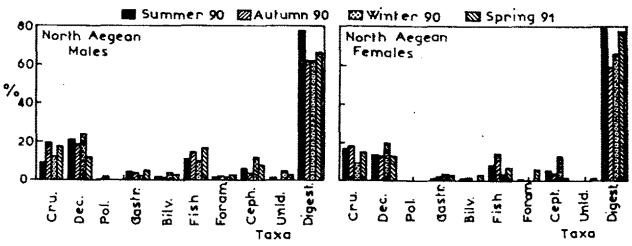

Fig.1. The F of the different taxa in the diet of Norway lobster.

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A new technique for transplantation of red coral *Corallium rubrum* (L.) in laboratory and on artificial reefs

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As far as we know, transplant experiments of Mediterranean Gorgonians already made have consisted of bringing cuttings of ramifications as well as juvenile colonies and placing them in habitats in which the species involved were not usually encountered or had almost disappeared (WEINBERG, 1979). Several transplant techniques were tested (concrete blocks, PVC-racks and transplanted stones) but two main systems of installation were employed :

1 - the branches or the entire ramifications were detached from the colony or from their original substratum and fixed directly to some artificial body (WEINBERG, cit.; F.A.O., 1988);

2 - stones (e.g. coralligenous rocks) bearing juvenile or adult colonies were collected from their environment and firmly transplanted in various sites.

The aim of the method described here is quite different and concerns only the species *Corallium rubrum*. Our object was to find a simple transplant technique for an easy transference of colonies from the laboratory to the field and vice versa. This could be useful to facilitate experiments and biometrical measurements, both in aquaria and at sea, and to have a high survival rate of the branches.

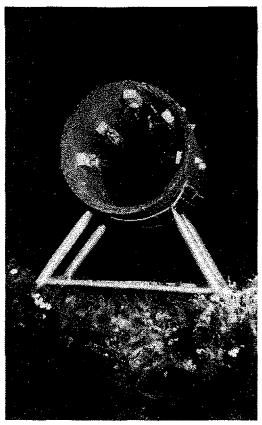
As far as the island of Sardinia is concerned, this must also be considered as the first scientific transplant of red coral onto artificial substratum in shallow waters. A similar experiment was carried out by some of the Authors. However the branches were transplanted directly on natural sustrata (CHESSA, com. pers.).

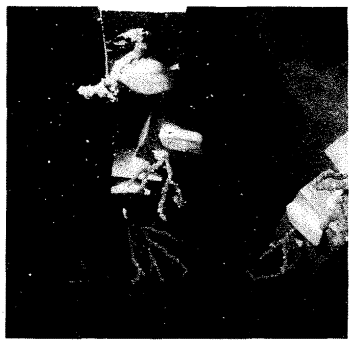
It is worthwhile mentioning that there has been intensive fishing by divers from superficial rocky bottoms and caves along all the Sardinia coast. In almost all of these biotopes this species has been completely destroyed and very few populations with good densities were observed (CHESSA *et al.*, 1991). For the above reasons this research is to be regarded of pratical interest.

The experiment was carried out in July 1991 along a rocky coast near Alghero (NW Sardinia). A number of small colonies of *Corallium rubrum* were collected in January 1991 from a shallow cave (15 m deep) where a surprisingly high density of the species was found (CHESSA *et al.*, cit.). Some environmental parameters were monitored *in situ* (e.g. temperature, salinity, dissolved oxygen, pH). The ramifications were detached with a little substratum and quickly put in a thermic bag and kept at the constant temperature of 15°C with aeration. Then they were taken to the laboratory and placed in aquarium under controlled environmental conditions.

The colonies were fed with *Artemia salina* nauplii twice a week for 24 hours at a concentration of about 2 nauplii/cc. In the above conditions the coral survived very well, without any regression of the coenenchima.

After 3 months of aclimatization in the aquarium, 11 ramifications were transplanted onto holes in small tiles. The holes had approximately the same diameter of the base of each colony. They were fixed with a quick-settling cement. These colonies were kept under strict observation for 3 months before being transferred to the sea. In this period no significant alterations in the living tissues at the base of the branches were observed.





Inside view of the pipe with ramifications transplanted (above).

The pipe placed *in situ* (left).

The tiles bearing the colonies were fixed underwater to the inside walls and roof of a small concrete pipe which had a metal base. This pipe was placed on a rocky bottom 25m deep close to calcareous outcrops where red coral was still present.

Checks on the red coral in the tunnel were made after 3 and 4 months and the following considerations can be made:

1) all the branches of the colonies survived;
2) the materials employed (tiles, cement, etc.) functioned well;
3) two portions of ramifications, detached by natural causes, transferred to laboratory are still surviving. They are now ready to be retransplanted into the field;
4) the transplant technique seems to be effective and easy to employ.

Even if it is too soon for a technological application of these results, the present experience demonstrated that red coral can be manipulated quite easily and does not seem as delicate as was previously supposed. Taking into consideration all the above reasons we think that a massive transplantation could be undertaken in the near future.

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Notes sur la signification écologique de la malacofaune d'un "Trottoir à vermets" le long de la côte de Palerme (Sicile)

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Les *plateformes* à vermets ont été décrites par MOLINIER et PICARD (1953) le long des plages rocheuses près d'Isola delle Femmine, à l'ouest de Palerme. Il s'agit de formations biogéniques littorales, typiquement thermophiles, produites par le concrétionnement des coquilles de mollusques vermétidés auquel s'ajoutent de nombreux organismes à squelette calcaire: algues, foraminifères, serpulidés. Leur distribution est limitée à quelques sites de la partie méridionale et sud-orientale du bassin méditerranéen, notamment en Algérie et en Israël (FISHELSON, 1985; POR, 1985). En Sicile, ces communautés très particulières occupent seulement la côte nord-occidentale, où elles bordent les terrasses calcarénitiques littorales et les récifs calcaires, en disparaissant ou en se réduisant selon que les falaises sont très battues ou à l'intérieur des golfes, où elles sont remplacées par d'autres formations biogéniques. Afin de mettre au point un cadre biologique de ce milieu, nous avons entrepris une recherche dans le biotope rocheux de Capo Gallo, près de Palerme, où la plateforme peut atteindre 4m de large, avec une épaisseur allant de 20 à 60 cm dont la limite inférieure est marquée par la ceinture de *Cystoseira amentacea* var. *amentacea*. Nous avons appliqué les méthodes d'analyse bionomique, en étudiant du point de vue qualitatif et quantitatif la faune présente dans 23 échantillons de forme carrée sur une surface de 400 cm2, récoltés à chaque saison pendant un an. Un échantillonnage témoin a aussi été effectué sur une corniche de *Lithophyllum lichenoides* dans le même biotope. On a choisi le groupe des Mollusques comme descripteur des conditions du milieu, en étudiant en détail la distribution spatiale. Comme l'avaient déjà observé MOLINIER et PICARD (o.c.), la plateforme est formée de trois parties: 1° - une partie plus externe en forme de mamelon rocheux, exposée au déferlement des vagues;

2° - une cuvette toujours recouverte d'une d'eau plus ou moins haute, qui peut donner lieu à des flaques sursalées en été;

3° - une partie intérieure qui reproduit partiellement la partie extérieure.

Ces trois portions sont soumises de manière différente aux facteurs hydrodynamiques de sorte qu'on observe des variations très brusques au niveau du micromilieu. Après examen taxonomique approfondi, l'espèce responsable des bioconstructions est surtout *Dendropoma petraeum* (MONTEROSATO, 1892), qui *était* connue sous le nom de*Vermetus cristatus* (AA. non BIONDI, 1847), un gastropode sessile dont la coquille tubuleuse est fermée à son extrémité par un épais opercule corné qui lui permet de résister aux périodes prolongées de sécheresse consécutives à l'émersion (CHEMELLO et *al.*, 1990). Quarante-six taxa de Mollusques ont été identifiés, dont 11 montrent des valeurs maximales de fréquence, dominance et abondance. Aucune de ces espèces n'est toutefois exclusive sur la plateforme, du fait de leur appartenance aux niveaux les plus superficiels sans caractéristiques particulières. On a établi l'existence de deux stocks principaux: le premier est composé d'espèces typiques de l'horizon inférieur de l'étage medio-littoral et le deuxième d'espèces de la partie supérieure de l'étage infralittoral.

La distribution des deux peuplements est en relation avec les discontinuités spatiales de la plateforme: les indicateurs typiques du mésolittoral sont localisés sur les marges élevées externes et internes; les espèces typiques de l'infralittoral sont concentrées dans la cuvette centrale. Le bord externe est l'habitat préférentiel des espèces suivantes: *Lepidochitona caprearum, Patella ulyssiponensis, Fossarus ambiguus, Lasaea rubra, Onchidella celtica*, toutes liées au mésolittoral inférieur et au concrétionnement de *Lyhophyllum* (BELLAN-SANTINI, 1969). *L. rubra* et *O. celtica* sont exclusives de ce microhabitat. Le chitonidé *Acantochitona fascicularis*, les microgastropodes *Nodulus contortus* et *Eatonina fulgida*, vivent dans les microcavités à l'intérieur de la plateforme; les pelécypodes *Cardita calyculata* et *Mytilaster minimus* sont, au contraire, distribués uniformément sur la plateforme. La présence de C. *calyculata* est toutefois peu abondante et liée aux débris s'accumulant au fond des microcavités; *M. minimus* est une espèce dominante, représentée par de nombreuses populations qui peuvent atteindre des valeurs maximales de recouvrement en fonction du degré d'eutrophisation des eaux et des flux de matière organique particulée. La taille des individus montre un accroissement en relation avec le trophisme des eaux. Le peuplement endolithique du concrétionnement est représenté par *Lithophaga lithophaga, Petricola lithophaga et Irus irus*.

L'analyse factorielle du peuplement au moyen d'un dendrogramme de distribution horizontale des organismes donne trois regroupements principaux correspondant respectivement: a - au peuplement du **bord externe**; b - au peuplement des **marges internes** et, c - aux aggrégations d'espèces récoltées à l'**intérieur de la cuvette.** Cette distribution décrit d'une facon satisfaisante la succession dans l'espace des différents micromilieux. L'ensemble des groupes d'espèces est réparti d'une manière significative le long des deux axes de l'AFC, auxquels on peut assigner respectivement la distribution meso-infralittorale et le gradient hydrodynamique.

On peut conclure en soulignant, parmi les aspects les plus remarquables de la *plateforme à vermets*, son extension sur un plan parallèle et très proche de la surface de la mer, qui a pour effet de créer une **zonation horizontale** entraînant, dans un espace nécessairement réduit, des variations considérables de facteurs tels que l'hydrodynamisme, le degré d'humectation, et sa durée. Ces facteurs atteignent des valeurs critiques surtout à l'occasion des marées syzygiales, lorsque les surfaces demeurent longtemps desséchées et qu'un grand nombre d'espèces disparaissent.

Du fait de leur développement horizontal les *plateformes à vermets* sont une communauté complexe résultant d'au moins deux composantes: l'une est donnée par l'ensemble des micromilieux capables de garder un degré constant d'humectation, qui constituent un habitat pour les espèces infralittorales; l'autre est la position élevée sur la mer, qui permet la colonisation par des organismes du mesolittoral.

De ce point de vue les "trottoirs à vermets" sont des **dilatations des horizons superficiels:** ils créent des habitats supplémentaires qui fournissent des refuges et augmentent la chance de survie et de reproduction d'un nombre considérable d'organismes marins. Leur existence est un aspect non négligeable des milieux de la Méditerranée méridionale, qui mérite la plus grande attention des spécialistes.

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Estimation of Past Primary Production of *Posidonia oceanica* using Lepidochronological Data

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Estimation of primary production in marine phanerogams is usually based on :

(i) the growth rate of the biomass (leaf marking-method - ZIEMAN, 1974),

(ii) measurement of the intensity of photosynthesis (the oxygen method - OTT, 1980, and the carbon 14 method - Mc ROY, 1974).

These methods are time-consuming and involve certain technical difficulties; as a result, the site studied are usually few and relatively shallow.

A new method based on lepidochronological data has recently been tested (PERGENT & PERGENT-MARTINI, 1991). This method is very accurate and much quicker, and means that the limitations of the classic techniques can be overcome. A further advantage is that, for the first time, primary production can be estimated not only for the period under investigation, but also for preceding years.

As part of a European Communities Commission programme (N°EV4V-01 39-B), a study was carried out, between July 1988 and July 1990, at three sites (5, 10 and 20 m depth), in Lacco Ameno (Ischia Island, Italy). Primary production of these three sites was measured during this period by lepidochronological analysis (PERGENT, 1990; PERGENT & PERGENT-MARTINI, 1991). Parameters taken into consideration were :

(i) Number ot leaves produced per year,

(ii) Mean leaf length (over a one year period), and

(iii) Leaf density (SAND-JENSEN, 1975).

Primary production for preceding years can be estimated by using various parameters :

(i) Number of leaves produced for a given year (= number of petioles per cycle),

(ii) Length of fallen leaf during a given year, estimated by measuring the length of the petiole of the cycle (using the correlation between the length of the petiole and the total leaf length),

(iii) Leaf density, measured over a one year period,

(iv) Meadow density (number of shoots per m²).

Estimation of primary production, for the three sites, is based on a period of five years (Table I, Figure 1). Primary production decrease with depth, which is explained by the drop in meadow density (number of shoots per m²) and shoot production combined (Table II).

LA10	Number of leaves per year	Petiole length (in mm)	Leaf length (2) (in mm)	Leaf density (mg dw/cm)	Leaf production (g dw/shoot)	Meadow density (m²)	Leaf production (g dw/m²)
1990	8.7	42.1	400.6	4.5	1.57	351	551
1989	6.4	40.1	353.4	4.5	1.02	351	358
1988	7.6	41.7	391.1	4.5	1.34	351	470
1987	8.1	42.2	402.9	4.5	1.47	351	516
1986	7.3	44.5	457.2	4.5	1.50	351	527

Table I: Estimated primary production of *Posidonia oceanica* at site LA10.
* = Regression line between petiole length and total leaf length is : y = -593 + 23.6 x (in PERGENT & PERGENT-MARTINI, 1991).

Table II: Meadow density and shoot primary production (mean over 5 years) at Lacco-Ameno.

Sites	Meadow density	Shoot production
LA05	473	1.59
LA10	351	1.38
LA20	253	0.81

Primary production is relatively stable at depth (site LA20). Nevertheless there is greater variation by year for the shallower stations (site LA10 and LA05).

These variations appear to be synchronous; primary production for these two stations reachesits maximum in 1986 and minimum in 1989.

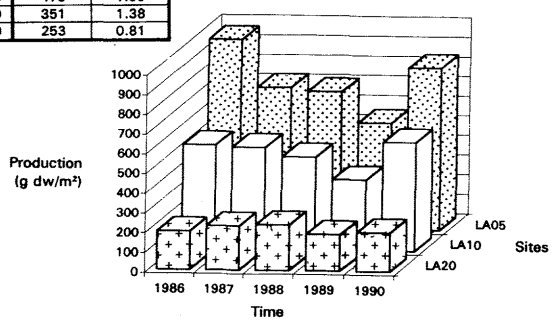

Figure 1: Estimated primary production of *Posidonia oceanica* meadow in three sites of Lacco-Ameno.

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B

B

Analyse phénologique et lépidochronologique de *Posidonia oceanica* dans une lagune hyperhaline du Sud Tunisien

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Posidonia oceanica est une phanérogame marine endémique de la Méditerranée qui constitue de vastes prairies sous-marines (appelées herbier) entre la surface et 30 à 40 m de profondeur. Du fait de leur sensibilité à la dessalure, ces herbiers, qui constituent une ceinture quasi continue tout autour du bassin Méditerranéen, s'interrompent au niveau du débouché en mer des grands fleuves (Nil, Pô, Rhône) (BOUDOURESQUE et MEINESZ, 1982). Si l'action de la dessalure sur l'herbier est donc bien connue, en revanche il est encore difficile de fixer avec précision la tolérance de la plante aux variations de salinité, même si un intervalle de 33 à 40‰ est proposé par BEN ALAYA (1972).

La Bahiret el Biban, située à la frontière tuniso-libyenne, est un bassin paralique d'une superficie d'environ 25000 ha (MEDHIOUB, 1979). La salinité de cette lagune oscille entre 410‰ et 520‰ pour une valeur moyenne de 46‰ (Figure 1). La salinité augmente depuis la passe d'El Biban jusqu'aux extrémités confinées de la lagune. Les fonds de la Bahiret el Biban sont en quasi totalité recouverts par un vaste herbier à *Cymodocea nodosa* localement associé à l'algue *Caulerpa prolifera*. C'est en 1981 que la présence d'un herbier à *Posidonia oceanica* a été signalé pour la première fois (ZAOUALI, 1982), dans le Sud du bassin (Figure 1).

Dix faisceaux ont été prélevés en juillet 1991 à proximité du petit port de La Marsa à deux mètres de profondeur dans un herbier mixte à *Posidonia oceanica, Cymodocea nodosa* et *Caulerpa prolifera*. Ces faisceaux ont fait l'objet d'une étude phénologique (GIRAUD, 1977) et lépidochronologique (PERGENT, 1990).

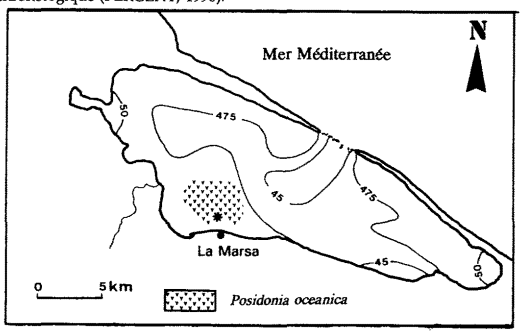

Figure 1 : La Bahiret el Biban, avec localisation de l'herbier à *Posidonia oceanica*. Les salinités de surface, mesurées en août 1976 sont indiquées (d'après MEDHIOUB, 1979).
* = zone de prélèvement.

Table 1 : Analyse phénologique de dix faisceaux prélevés en juillet 1991 dans la Bahiret el Biban.

	Adultes	Intermédiaire	Juvéniles	Global (Ad + Int)
Biométrie foliaire				
- Nombre	4.4	1.9	2.2	6.3
- Longueur (mm)	324.6	146.2	10.7	270.8
- Largeur (mm)	9.1	9.1	5.8	9.1
Coefficient A (%)	93.8	9.5	68.1	
Leaf Area Index (cm²/faisc)	130.0	25.3		155 3

Cet herbier est constitué en majorité de rhizomes plagiotropes (70%) ou de rhizomes orthotropes récents (1 à 5 ans). Dans ce secteur, il semble que l'herbier est en phase de colonisation du substrat: petites touffes dispersées (5 à 30 faisceaux), nombreux rhizomes traçants, absence de matte sous jacente. La présence d'un herbier à *Cymodocea nodosa* qui est une espèce pionnière dans la série évolutive de l'herbier à *Posidonia oceanica* semble accréditer cette hypothèse.

La biométrie foliaire des faisceaux récoltés, ainsi que le coefficient A et le Leaf Area Index (Tableau I) sont tout à fait comparables aux mesures réalisées dans d'autres secteurs de Méditerranée (PERGENT et PERGENT-MARTINI, 1988). L'analyse lépidochronologique semble également tout à fait compatible avec les mesures effectuées dans d'autres localités (PERGENT et PERGENT-MARTINI, 1991), le nombre de feuilles produites en une année est de 7.7, alors que la vitesse de croissance moyenne des rhizomes, est assez élevée 11.3 mm/an, ce qui semble traduire une sédimentation importante dans ce secteur.

Toutefois, si l'on compare ces résultats à des mesures effectuées sur des faisceaux prélevés à la même période, et à une profondeur équivalente, en mer ouverte (Nord Ouest de l'île de Jerba), nous constatons que les valeurs enregistrées à Jerba sont plus élevées: le nombre de feuilles produites annuellement est de 9.4, et la vitesse de croissance des rhizomes est de 21.4 mm/an. Cette vitesse de croissance élevée est peut être en rapport avec les problèmes sédimentaires que connaît actuellement l'île de Jerba.

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Memorization of heavy metals by *Posidonia oceanica* preliminary results

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The aims of this preliminary study, which is part of the European Community Commission STEP programme (STEP - 0063 - C), are the quantification of trace elements stored in the living part of the meadow (e.g. heavy metals), and an investigation of whether rhizomes and sheaths, which decay little, can provide a record of previous trace element content level, and thus provide a means of reconstituting the chronology of content level over a long period (10 to 30 years). In fact, for Cesium 137, it has been shown that rhizomes and sheaths "memorise" the content level that prevailed at the time of their original growth (CALMET *et al.*, 1988).

This study was carried out on different Mediterranean sites; these preliminary results only concern the Marseilles area (in the vicinity of the Cortiou out, station - 10 m). Three replicates of ten orthotropic rhizomes were collected at random by SCUBA diving. For each shoot, sheaths and rhizome segments were carefully detached, according to the lepidochronological method (PERGENT, 1990). For each lepidochronological year, heavy metal content in the various parts of the plant are measured by atomic absorption.

These preliminary results provide evidence of :

(i) The accumulation of various trace elements that are present in the environment by *Posidonia oceanica* according to AUGIER *et al.* (1980), CALMET *et al.* (1988) and PANAYOTIDIS *et al.* (1990),

(ii) A decrease in heavy metal content levels since 1975 (Figure 1), including iron, which gives distinctly higher values (from 931 to 175 µg/g).

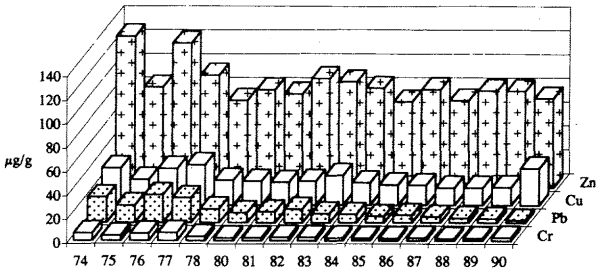

Figure 1: Heavy metal concentrations in *Posidonia oceanica* (in µg/g) en fonction of lepidochronological year.

(iii) Significant correlations between sheaths and rhizomes for lead, iron, chrome and for zinc, the correlation is negative (Figure 2).

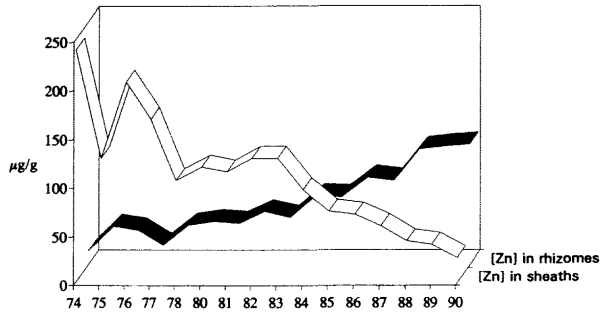

Figure 2: Zinc content (in µg/g) in *Posidonia oceanica* sheaths and rhizomes with lepidochronological year.

(iv) There are significant correlations between the lead content recorded in the water or the sediment, within the same area (c.f. Réseau National d'Observations de la Qualité du Milieu marin) and that measured in the *Posidonia oceanica* rhizomes.

Nevertheless, it would be premature at this stage to offer any interpretation of these results, which require confirmation after further analysis.

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Le Port d'Alger : les peuplements des substrats meubles

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L'étude des conditions du milieu et celle de la composition faunistique de 34 stations du port d'Alger (bassins Mustapha, Agha et Vieux Port) a mis en évidence la spécifité de chacun de ces bassins. La méthodologie adoptée a fait l'objet d'un travail de BAKALEM *et al.* (1986).

Résultats

Bassin Mustapha: Le peuplement est ici limité au niveau de l'aire d'évolution des navires, il s'étend aux sorties de darses en hiver et se réduit en été et en automne aux secteurs sous l'influence des eaux de la baie pénétrant dans le Port par la passe sud. Le peuplement, très peu diversifié, est constitué par deux espèces de polychètes indicatrices de pollution de premier rang (IP1), seules représentées dans la *zone polluée interne: Capitella capitata* et *Malacoceros fuliginosus* (REBZANI-ZAHAF, 1990). Les plus fortes densités de populations du Port d'Alger, ont été observées dans ce bassin, elles peuvent atteindre plus de 25000 individus par m2 *Capitella capitata* supporte les rudes conditions du milieu; elle est responsable des fortes poussées quantitatives aux stations où subsistent un peuplement constant et elle est susceptible de peupler les stations azoïques; *Malacoceros fuliginosus* est abondante en hiver.

Bassin de l'Agha: Son peuplement est plus diversifié (maximun 18 espèces) et la densité est élevée (10832 individus/m2 au printemps), sans pour autant atteindre les pics quantitatifs du bassin Mustapha. Le groupe faunistique dominant est celui des Polychètes, suivi des Mollusques, les Crustacés sont faiblement représentés. L'évolution saisonnière des stations a permis de mettre en évidence une alternance de forte dominance des *Capitella capitata* et *Malacoceros fuligenosus* (IP1) avec les indicatrices de pollution de second rang (IP2) telles que *Polydora antennata, Strauroceph alus rudolphii, Nereis caudata, Audouinia tentaculata* qui apparaissent dans la zone polluée externe. Les espèces à large répartition écologique (LRE) sont représentées par le mollusque *Corbula gibba*. La situation intermédiaire de ce bassin révèle un état d'équilibre instable du peuplement qui peut basculer selon l'augmentation ou la diminution de la charge polluante.

Bassin du Vieux Port: Son peuplement, en fonction de l'emplacement des stations prospectées, se répartit ainsi:

-une dominance des espèces LRE, particulièrement *Corbula gibba* indicatrice de matière organique, dans les stations des fonds de darses et dans le secteur situé à proximité du bassin de l'Agha,

-une codominance des LRE et des espèces indicatrices d'instabilité (Ind.Ins) avec respectivement *Corbula gibba* et *Tharyx marioni* en tant que principales espèces, localisées aux sorties de darses et à une partie du bassin d'évolution des navires,

-une dominance des indicatrices d'instabilité essentiellement représentée par *Tharyx marioni* qui se localise dans les régions sous l'influence des eaux du large de la baie. Cette répartition se fait graduellement, des stations situées dans le fond des darses vers le bassin d'évolution d'une part et de la passe nord vers le bassin de l'Agha d'autre part. Le peuplement de ce bassin se caractérise par sa richesse qualitative (33 espèces) et une densité moyenne de 2734 ind./m^2. L'évolution du peuplement révèle une augmentation progressive depuis l'automme jusqu'au maximum printanier, suivi d'une diminution en été. Les principaux groupes faunistiques sont les Polychètes dont la Dominance moyenne (D.M.) atteind 38,67, les Mollusques (D.M. 46,20) et les Crustacés (D.M. 11,13). Les espèces indicatrices de pollution ne sont pas très abondantes; les IP1 sont absentes ou très faiblement représentées, les IP2 ont une dominance peu élevée, ne dépassant pas 15%. Les groupes écologiques les mieux représentés sont les LRE (*Eunice vittata, Lumbrinereis latreilli, Notomastus latericeus*...), le Mollusque *Corbula gibba* domine largement. Lorsque la dominance des LRE décroit, les espèces telles que *Taryx marioni, Abra alba, Prionospio malmgreni, Glycera convoluta* se mettent en place. Ce regroupement d'espèces semblerait indiquer une amélioration de l'état du milieu.

Caractéristiques du peuplement des bassins

	Automne	Hiver	Printemps	Eté
MUSTAFA				
Abondance	1918	6370	549	128
Nbre d'espèces	2	2	2	2
Densité/m^2	7672	25480	2196	512
Dom. *C. capitata*	56,46	84,81	59,38	96,87
" *M.fuliginosus*	43,58	15,18	40,61	3,12
AGHA				
Abondance	204	1268	2708	288
Nbre d'espèces	10	15	18	10
Densité/m^2	816	5072	10832	1152
Dom. IP1	64,33	30,74	12,92	65,88
" IP2	28,57	60,78	74,87	21,05
" LRE	2,02	6,61	10,20	13,02
VIEUX-PORT				
Abondance	550	797	792	595
Nbre d'espèces	30	34	35	32
Densité/m^2	2200	3188	3168	2380
Dom. LRE	44,82	39,11	46,25	42,81
" Ind. Inst.	33,37	37,81	35,36	35,98
" IP(1+2)	11,31	14,76	7,62	11,37

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Le genre *Elphidium* dans les herbiers de *Posidonia oceanica* (L.) Delile

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L'étude sur les espèces des foraminifères épiphytes sur *Posidonia oceanica* (L.) Delile du Cap Creus (Girona, Catalogne), a permis de comptabiliser et déterminer 7427 individus du genre *Elphidium*, représentés par les espèces et varietés suivantes : *Elphidium macellum, E. macellum var. aculeatum, E. crispum, E. advenum, E. complanatum, E. maioricensis.*

La famille des Elphidiidae représente le 27,62% de la population de foraminifères déterminés, ce qui est une valeur très semblable à celle observée par BLANC-VERNET (1984) dans un herbier de posidonie de la Méditérranée orientale.

Les échantillons qui font l'objet de cette étude proviennent de 6 stations situées au Cap Creus (Fig. 1).

Ils ont été recueillis directement au moyen d'un scaphandre autonome entre 2 m. et 20 m. de profondeur, durant les mois de mars et de septembre. La surface de prélèvement était de 20 x 20 dans l'herbier de posidonie, ceci afin d'homogénéiser la taille des échantillons. Une fois au laboratoire, on a procédé au lavage des feuilles et au filtrage du liquide obtenu et on est passé au triage et à la classification de tous les exemplaires trouvés. On a calculé la Dominance Générale Moyenne et le taux de Fréquence selon le critère de SOYER.

$$Dm = \frac{n}{N} \times 100$$

$$F = \frac{m}{M} \times 100$$

ou :

n = nombre total d'exemplaires de l'espèce.
m = nombre total d'exemplaires de toutes les espèces trouvées.
N = échantillons ou apparaît l'espèce en question.

Toutes les espèces qui dépassent 1% de Dominance Générale Moyenne sont dominantes dans la population étudiée.

Selon le taux de Fréquence :
espèces constantes F > 50%
espèces accessoires 25% <F < 50%
espèces accidentelles F < 25%

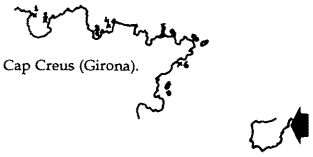

Fig. 1. Situation des stations prospectées au Cap Creus (Girona).
1- Punta Sernella
2- El Pas
3- Cala Taballera
4- Cala Prona
5- Cala d'Agulles
6- Cala Fredosa

	Dominance Générale Moyenne	Fréquence
Elphidium advenum	0.900	92.86 (C)
Elphidium complanatum	0.700	100,00 (C)
Elphidium crispum	0,800	92,86 (C)
Elphidium macellum	14,500 (D)	100,00 (C)
Elphidium macellum var. *aculeatum*	9,610 (D)	100,00 (C)
Elphidium maioricensis	0,007	14,29 (A)

Au Cap Creus, la famille des Elphidiidae est seulement représentée par le genre *Elphidium*, celui-ci étant un des plus représentatifs des herbiers de *Posidonia* de cette zone-là.

On observe un léger accroissement du nombre des espèces dans les profondeurs où les conditions sont plus stables, mais, ceci dit, les différences ne sont pas très significatives car il s'agit de zones littorales.

On a trouvé un plus grand nombre d'individus dans les échantillons du mois de mars que dans ceux du mois de septembre, ce qui aurait à voir avec le cycle de la posidonie, qui perd une partie de ses feuilles pendant le mois de septembre. La différence numérique des espèces à telle ou telle autre profondeur dans les différentes stations est due à l'orientation de ces dernières et à l'incidence des vents dominants qui occasionnent un mouvement des eaux plus important, ceci donnant lieu à une plus grande instabilité des espèces adhérant aux feuilles (Tableau II).

L'espèce *Elphidium macellum* se trouve en grand nombre sur la surface foliaire de la posidonie, où les conditions d'éclairage et d'oxigénation qui lui conviennent se trouvent réunies (BLANC-VERNET, 1967; RIBES, 1987).

L'observation des taux de Dominance Générale Moyenne permet d'établir que l'espèce dominante dans cette zone est *Elphidium macellum*, suivie de l'une de ses variétés : *E. macellum* var. *aculeatum*.

	PA-15	PR-2	TA-3	TA-4	TA-5	TA-6	S-7	S-8	PA-9	PA-10	AG-11	AG-12	FR-13	FR-14
E. advenum	-	17	10	14	9	18	10	95	21	10	4	4	25	10
E. complanatum	1	3	1	15	10	27	24	39	18	18	6	10	10	15
E. crispum	-	14	5	32	22	17	25	20	16	21	7	3	40	10
E. macellum	4	150	269	450	358	369	326	359	388	383	120	143	518	306
E. mac. var. a.	183	117	100	345	235	182	278	275	275	190	70	86	215	145
E. maioricensis	-	-	-	-	-	-	1	1	-	-	-	-	-	-

Tabl. II.- Liste des espèces de Foraminifères et nombre d'individus par station. (PA-15 : 10 m., PR-2 : 20 m., TA-3 : 5 m., TA-4 : 18 m., TA-5 : 5m., TA-6 : 20 m., S-7 : 2 m., S-8 : 10 m., PA-9 : 13 m., PA-10 : 17 m., AG-11 : 3 m., AG-12 : 6 m., FR-13 : 3 m., FR-14 : 11 m.).

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Decomposition of *Posidonia oceanica* leaf litter : litter bag experiments

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There has been a considerable amount of research into the kinetics of decomposition (fragmentation, chemical composition and nutritional value) of the dead leaves of marine phanerogams (litter) (RUBLEE & ROMAN, 1982; WAHBEH, 1988), but relatively few studies have been devoted to *Posidonia oceanica* litter (FRANCOUR, 1990; PERGENT-MARTINI *et al.*, 1990). Despite this, the litter compartment does play a role of primary importance in the functioning of the *Posidonia oceanica* ecosystem (ROMERO *et al.*, in press).

The aim of the present study, which is part of an extensive European Communities Commission programme (STEP Programme), is twofold :

(i) to quantify the amount of the leaf litter, and its variation in space and time (monthly samplings in several stations);

(ii) to analyse the kinetics of decomposition of the leaves.

The findings presented in the present article deal only with the second of these aims.

These *in situ* decomposition investigations were carried out in the Marseilles (France) area. In all, three stations were used : two stations at - 10 m depth (Riou 10 and Cortiou 10) and one station at - 18 m depth (Riou 18). The investigations took place from the 9th July to the 4th December 1991.

Material for incubation was collected from living plants; the oldest senescent leaf of each shoot was chosen in order to simulate a natural leaf abscission. It was weighed (sub-samples of 30 +/- 0.5 g fresh weight) and was enclosed in bags (mesh size : 1 mm) sealed with strips of velcro. The bags were then placed in the meadow under foliar canopy and collected at increasing time intervals (1, 2, 3, 4 weeks; 2, 3, 5 months). Three series of bags were placed at both Riou 10, Cortiou 10, and Riou 18, in July 1991.

At each sampling time, three bags were collected at random and taken to the laboratory. There, the samples were washed, the fauna was eliminated and the foliar debris was separated into three size classes: leaves with a length of > 5 cm (large leaves); leaves with a length of between 5 cm and 8 mm (broken leaves), and leaf debris with a length of between 8 mm and 1 mm (debris). Each fraction was dried in the dryer at 60°C (constant weight), then weighed.

The totality of the samples was powdered (pulveriser). These results are only preliminary, and the carbon, nitrogen, and phophorus content, and the percentage of ash, must be determined by subsequent analyses.

The findings were compared with those resulting from similar investigations carried out (i) at Ischia (Bay of Naples, Italy) from July 1988 to July 1989, and at Marseilles (stations Riou 10 and Riou 18) from June to December 1989. Hydrological conditions in the bay of Lacco Ameno (Ischia, Italy) are generally calm (MAZZELLA *et al.*, 1986), whereas the stations at Cortiou and especially Riou are much more exposed, and subject to very strong currents.

A weight loss with time was apparent in the incubated material. The loss followed a simple negative exponentiel model, (linear after logarithmic transformation of the data). Highly significant correlations were found between the total dry weigth (in g) and the decomposition rate on the one hand, and between the dry weight of large leaves (leaves > 5 cm) and the decomposition rate on the other.

These preliminary findings confirm the patterns of decomposition kinetics observed not only (i) during previous investigations at Riou, but also (ii) during experiments at Ischia :

- at similar depths, the rate of decomposition of leaves is comparable whatever the site (no significant difference between the slopes of the various regression lines);

- decomposition is faster in the surface stations and in those subject to strong hydrodynamic forces (e.g. Riou) (fig.); - in addition to fragmentation resulting from purely mechanical factors (e.g. hydrodynamism forces), evidence is also provided of biological fragmentation (e.g. amphipodes). The period when the experiments are set up (summer or winter) also appears to influence the decomposition kinetics (ROMERO *et al.*, in press). A further series of experiments using litter bag was started in January 1992 at the same stations with a view to providing confirmation for this hypothesis.

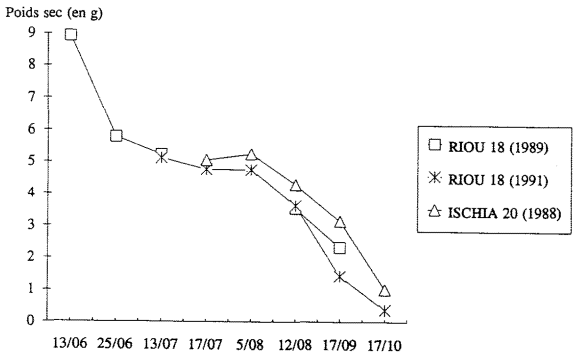

Figure : Dry weigth (in g) of large leaves (leaves > 5 cm), at two stations: Riou (-18m) and Ischia (- 20m).

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Bryozoans of a coastal detritic bottom off Pachino (South-Eastern Sicily)

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Bryozoans represent one of the most common and characteristic elements of detritic bottoms in general and are very significant within the Biocenosis of Coastal Detritic Bottoms (*sensu* PERES & PICARD, 1964). Assemblages such as these have been studied for the area around Marseilles (HARMELIN, 1976) and the Hyeres Islands (HARMELIN, 1978), in the Aegean area (HARMELIN, 1968; 1969) and along the coasts of Catalania (ZABALA, 1986). This paper represents a first approach to the study of this type of association in the Central-Southern Mediterranean.

The Bryozoan assemblage of a particular facies of the Coastal Detritic Biocoenosis, characterized by strong hydrodynamism with a community prevalentely made up by the mollusks *Modiolula phaseolina, Laevicardium oblongum, Pteromeris minuta, Calyptraea chinensis*, and the Echinoderm *Echinocyamus pusillus* and a thanatocoenosis characterized by the extreme abundance of calcareous Algae of the species *Mesophyllum lichenoides* was studied. The sample (PS/81 10 C) comes from the continental shelf of South-Eastern Sicily (Bay of Noto); it was dredged two and half miles off the coast of Pachino (Lat. 36°43,48 N; Long. 15°11,30 E) at a depth of between 61 and 57 metres. In this zone there are several biotopes largely characterized by coarse, organogenic sediments recording an autigenous productivity, often placed side by side with rocky bottoms colonized by the Coralligenous Biocoenosis (VIOLANTI *et al.*, 1990).

The faunistic content of about 30 litres of bottom sediment was analyzed. Granulometrically, it is a gravelly sand with a subordinate muddy fraction and an exclusively organogenic composition. The characterizing element is given by the calcareous Algae (84%), while the rest is essentially made up of Mollusks and Bryozoans. Echinoderms, Crustaceans, Serpuloids and Cnidarians are distinctly subordinate.

A total of 13 species were determined (2 Cyclostomes, 6 Cheilostomes Anascina and 5 Cheilostomes Ascophorina). Within the assemblage, made up overall by 131 colonies, the most abundant species are *Beania hirtissima hirtissima* and *Beania robusta* which together reach 49.26%, followed by *Calpensia nobilis* and *Setosella vulnerata* each with 11.45%, by *Schizobrachiella sanguinea* with 9.92% and *Copidozoum planum* with 4.58%. *Annectocyma major* and *Hincksinoflustra octodon* are present each with 3.05%. All the other species are much more subordinate *(Entalophoroecia deflexa, Hippopodinella kirkempaueri, Cleidocasmidra çanakkalense, Reptadeonella violacea* and *Turbicellepora coronopus)* each present with only two specimens and with 1.53%. It is to be noticed how almost all the species fall into the stock of characteristic (exclusive and preferential) species of the Coastal Detritic Bottom Biocoenosis with *Beania hirtissima hirtissima, Beania robusta, Calpensia nobilis, Reptadeonella violacea* and *Setosella vulnerata*. In particular, the first four species are linked to the small substrata which lie on the bottom such as shells or more often calcareous Algae, as has been already noted by GAUTIER (1962), HARMELIN (1976; 1978) and ZABALA (1986). On the other hand, *Setosella vulnerata* electively colonizes very small elements (1-2 mm) developing spiral-growth colonies but which never totally cover the substratum-grains. The species *Cleidochasmidra çanakkalense* was first noted here after its initial description on specimens from the Dardanelli Strait at depths between 60 and 70 metres (UNSAL & d'HONDT, 1979) and can also be included in the stock of Coastal Detritic Biocoenosis (ROSSO, in prep.). This species prefers to colonize the bulgy parts of the calcareous Algae. The ubiquist *Annectocyma major* and *Entalophoroecia deflexa*, here present with vincularform morphoses which are more typical of the lower surfaces of small elements lying on the bottom (HARMELIN, 1976; ZABALA, 1986), can also be considered characteristic of the Coastal Detritic Biocoenosis. Also the sciaphylous *Turbicellepora coronopus*, with small globular colonies which would be more typical of Shelf-Edge Detritic Bottom Biocoenosis (HARMELIN, 1978), could be included in such a stock. Finally we must consider as accidental *Schizobrachiella sanguinea* and *Hippopodinella kirchempaueri*, both having a typically infralittoral distribution, and *Hincksinoflustra octodon* which up until now was only known in deep and muddier stations in the westernmost part of the Mediterranean (ZABALA, 1986). From a compositional point of view, this assemblage shows more affinity with the Bryozoan assemblages from analogous Coastal Detritic Bottom Biocoenosis (between 60 and 100 metres) from the area around Marseilles (HARMELIN, 1976; 1978) than with those of the Eastern Mediterranean (HARMELIN, 1968; 1969). The number of species found (13) is, in any case, lower than that quoted from the Mediterranean localities (17-30) studied by HARMELIN.

The analysis of the zoarial morphotypes, with which the species of the assemblage are present, indicates that the bottom is influenced by a strong hydrodynamism. In fact, a very high percentage of encrusting forms can be seen (Membraniporiform, Petraliiforms, Setosellinoforms and Celleporiforms), as well as flexible erect types (Flustriforms) which overall represent about 95% of the zoarial forms present and which allow us to suppose that there are bottom currents of moderate to moderate-high intensity (*sensu* SCHOPF, 1969). The species with a Vinculariform habitus could develop in more sheltered micro-habitats. On the other hand, the inferred rate of sedimentation is low in that almost all the morphotypes, with the exception of Setosellinoforms, Flustriforms and Vinculariforms to a certain degree, do not like muddy conditions. These data agree well with the bottom granulometry (gravelly sand with a subordinate muddy component).

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Date Mussel (*Lithophaga lithophaga*) harvesting : evaluation of damage along the Sorrentine-Amalfitane Peninsula (Bay of Naples)

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The bivalve *Lithophaga lithophaga* colonizes calcareous rocks from the surface of the sea down to a depth of 20 m, with maximum density in the first five meters. The mussel bores cavities in calcareous rocks by means of acid or calcium-binding secretions, and lives in the cavities, extending them up to 20 cm into the hard substrate. Fishermen smash the rocks with axes or hammers to excavate the bivalve and thus destroy the substrate and the organisms living on it.

Lithophaga lithophaga grows very slowly, and takes about 20 years to reach minimum commercial size (5 cm). Therefore, after date mussel have been harvested it is several decades before the same sites can be fished again. Consequently, fishermen constantly seek and destroy new harvesting sites. In this light, the "exploitation by excavation" of date mussel "banks" can be considered "extractive" activity, like mining.

This is precisely what happens, in a manner always more devastating in these last years. With the recent increase in scuba diving, the situation has deteriorated dramatically, as shown by studies on the coasts of Dalmatia (HRS-BRENKO, 1991), Apulia (BOERO *et al.*, 1990), and of the Bay of Naples (RUSSO & CICOGNA, 1991, 1992).

The calcareous cliffs of the Sorrentine-Amalfitane Peninsula (about 70 km, from Vico Equense to Positano, Bay of Naples) have been proposed as a marine reserve (Law Nr. 979/1982). To evaluate damage to date mussel harvesting, the area was surveyed in the summer 1991 by 50 transects, extending from the surface of the sea down to a depth of 15 m, perpendicular to the coastline, 1 nautical mile apart.

Following BOERO *et al.* (1990), rock damage was evaluated by measuring the size and frequency of the "bare" patches due to the excavation activity, and classified as follows:

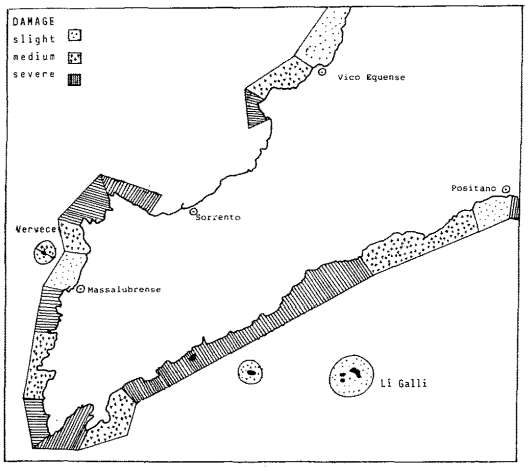
- rank 1: absence of damage;
- rank 2: slight damage (isolated patches, max. size 1/4 m2);
- rank 3: medium damage (scattered patches, max. size 1 m2);
- rank 4: severe damage (adjoining patches, size > 1 m2)

The results are shown in Fig.1. No sites without damage (rank 1) was recorded along the coast. Of the total investigated area, about 15% showed slight damage, about 35% medium damage, and about 50% severe damage.

The rank 2-type impact of harvesting was found around the rocks that extended far from the coast. Severe damages was observed on the steep cliffs near the main villages and along an extended area facing the Gulf of Salerno.

These results are alarming. Despite a law forbidding date mussel harvesting (D.M. 20/8/1988, and D.M. 2/8/1990), 50% of the total area showed "fresh" patches, indicating that excavation activity had been conducted during the year of the observations.

Stricter enforcement of the law and the sensibilization of the public opinion as to the problem are urgently required.



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Biological control of marine biofouling

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Marine biofouling is a mat made of bacteria, sea-weeds, and sessile invertebrates, which develops on man-made objects submerged in the sea. The mat makes the surface of ships' hulls uneven and rough. Due to the rough surfaces friction during movement increases, and speed is reduced. On stationary installations, biofouling intensifies corrosion, increases the mass of the installation and distorts its configuration. To combat biofouling, prior to submergence the object's surface is painted with "antifouling paints", which contain toxichemicals. The toxins initially prevent, later slow down the development of the mat, but eventually fade away. The vessel has to be drydocked, scraped and repainted. Stationary objects are scraped periodically by scuba-divers. These solutions are costly and never foolproof. Striving to improve effectivity the chemical industry produces chemicals of ever-increasing toxicity. The invention of Tributyltin has crossed the threshold between environmentally-safe and environmentally detrimental toxichemical. This chemical poisons the marine biota and damages mariculture.

We explore an alternative solution, biological control by limpets, applied to surfaces that should be protected. Limpets *Patella coerulea* can easily be detached from the shore and transplanted onto metal panels simulating a ship docked in the port of Ashdod, Israel (SAFIREL & EREZ, 1987). The transplanted limpets eat the unicellular algae and sporelings of the larger algae. While foraging for them the limpets crush and dislodge recruits of the fouling invertebrates. We found that the limpets accelerated the detachment and mortality of young recruiting barnacles *Balanus amphitrite*, presumably by repeated running over by the foot, thus undermining the barnacles' hold. Only when barnacles are > ca 1.5 mm in rostro-carinal diameter, they become safe from both physical detaching forces, and limpets.

We found that during winter, when fouling recruitment was slow, 15 limpets reduced the ca 90% biofouling cover of 20 x 20 cm experimental panels down to 1-3%, and barnacles density from 2.6-3.8 to 0.7-0.8 individuals/cm^2. With the commencement of the spring surge of fouling recruitment, the limpets controlling effect steadily deteriorated, but they continued to check the development of the high-mass bryozoan cover by the end of the 8 months-long experiment. The decline in limpets' controlling effect was due to a feed-back loop : heavy settlement of barnacles brought about an initial reduction in control that increased barnacles sizes and density. This induced accelerated mortality among limpets, bringing about a further increase in barnacles' density.

To achieve effective control, it is necessary to measure "Return time", tr, the time it takes a foraging limpet to return to a previously foraged location on the surface, and "Critical time" tc, the time it takes a fouling individual to get established on the surface such that limpets cannot remove it. The preferred density and size distribution of limpets is the one that achieves tr≥tc for the whole surface. The critical time for *Balanus amphitrite* ranges between 3-6 days. The recruitment rate with which the limpets have to deal with can be as high as 0.44 *Hydroides elegans*/cm^2/day and 0.06 *Balanus amphitrite*/cm^2/day.

Return time of *Patella coerulea* depends on its movement pattern. As of transplantation, limpets gradually increase their home range and mould territories. Their rate of movement increases with the density of recruiting algae, on which they forage. But the presence of other limpets also elicits movement, presumably for marking the surface with mucus, as a non-aggressive territorial defense measure. Even when algal density is low, a limpet moves more when there are many than when there are few other limpets on the surface to be protected. To find the optimal control, we develop a mathematical simulation model which is driven by these and other data on the life history of the fouling organisms, and the behavioral ecology of the limpets, obtained in field and laboratory experiments.

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B

B

Etude comparée de la croissance linéaire relative chez deux populations de l'oursin *Paracentrotus lividus* (Lamarck) du golfe de Tunis

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L'étude biométrique que nous avons entreprise a pour objet de comparer la croissance linéaire relative de quelques proportions du corps de l'oursin vivant sur des fonds de nature différente, l'un constitué d'herbier de Posidonies et l'autre de substrat dur couvert d'algues. La méthode statistique utilisée consiste, d'une part, à établir les équations d'allométrie par la méthode des moindres rectangles (A.M.R.) et à procéder à leur comparaison, et d'autre part, à calculer les indices morphométriques correspondant aux rapports en pourcentage des différentes variables sur le diamètre du test pris comme longueur de référence.

La collecte des échantillons d'oursins ayant servi à notre étude a été faite dans deux stations du secteur sud-est du golfe de Tunis. La première, celle de Port Prince, occupe un substrat dur couvert d'algues, profond de 4 m, la deuxième, celle de Sidi Rais, correspond à un herbier de Posidonies situé à 6 m de profondeur et à 150 m du bord de la plage. Des prélèvements mensuels ont été effectués dans les deux stations durant une année (1988-1989). Au total, plus de 1900 individus ont été examinés. A l'aide d'un pied à coulisse gradué au 1/10 de mm, nous avons mesuré le diamètre du test (D), la hauteur du test (H) prise dans un plan perpendiculaire à celui du diamètre ainsi que la hauteur de la lanterne d'Aristote (HI).

Les équations d'allométrie liant la hauteur au diamètre du test sont pour :

- le substrat dur à algues : $H = 0{,}249\ D^{1{,}200}$
- l'herbier de Posidonies : $H = 0{,}229\ D^{1{,}225}$

Dans les deux secteurs (Fig. 1), il existe une très bonne corrélation entre les deux variables. Les pentes significativement supérieures à 1 traduisent une relation d'allométrie fortement majorante et le taux de croissance est comparable chez les deux populations (tpe = 1,89 < 1,96). La figure 2, illustrant les variations de l'indice moyen H/D en fonction du diamètre, confirme bien cet accroissement majorant de la hauteur et les indices moyens sont très proches dans les deux sations : H/D = 0,538 sur le substrat dur à algues et H/D = 0,532 sur l'herbier de Posidonies.

Les équations de corrélation décrivant la relation entre la hauteur de la lanterne d'Aristote et le diamètre du test sont pour :

- le substrat dur à algues : $HI = 0{,}604\ D^{0{,}827}$
- l'herbier de Posidonies : $HI = 0{,}473\ D^{0{,}891}$

Il existe dans les deux stations une très bonne corrélation entre les deux paramètres considérés (Fig. 3). Les pentes des droites, significativement inférieures à 1, traduisent une allométrie minorante. Le taux de croissance est cependant légèrement plus élevé dans l'herbier de Posidonies que sur le fond dur à algues (tpe = 3,68 > 1,96). Les représentations graphiques (Fig. 4) de l'indice moyen HI/D en fonction des classes de taille confirme cette croissance minorante de la hauteur de la lanterne. L'indice est égal à 0,306 pour le substrat dur contre 0,312 pour l'herbier de Posidonies.

L'analyse des résultats de la croissance linéaire relative des deux variables (H) et (HI) nous permet de formuler la conclusion suivante : on trouve toujours la même nature d'allométrie pour les variables considérées, mais l'intensité du rythme de croissance change, celui-ci étant légèrement plus rapide sur l'herbier de Posidonies.

Confrontées avec les données de REGIS (1978) sur le golfe de Marseille, nos résultats ne se vérifient que partiellement. La croissance de la hauteur du test est différente dans les deux secteurs français et tunisien. Toutefois, on peut noter dans les deux régions un même accroissement majorant de la hauteur du test sur les herbiers de Posidonies. La croissance de la hauteur de la lanterne est minorante aussi bien dans le golfe de Tunis que dans celui de Marseille, mais ce taux semble varier avec la nature du milieu dans le golfe de Tunis alors que dans le golfe de Marseille il reste inchangé quel que soit le substrat.

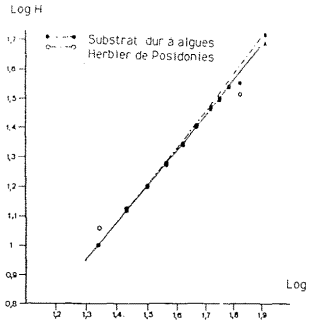

Fig. 1: Relation entre la hauteur (H) et le diamètre(D).

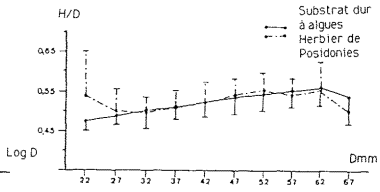

Fig. 2: Variations de l'indice moyen (H/D) en fonction du diamètre (D).

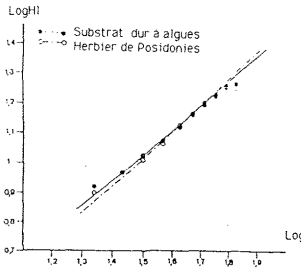

Fig. 3: Relation entre la hauteur de la lanterne (HI) et le diamètre (D).

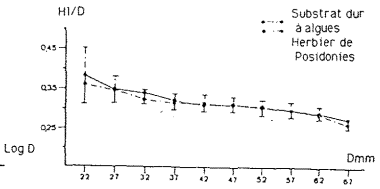

Fig. 4: Variations de l'indice moyen (HI/D) en fonction du diamètre (D).

Les barres verticales représentent l'intervalle de confiance de la moyenne.

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A propos d'une population de *Posidonia oceanica* (Posidoniaceae) de la région d'Alger (Algérie)

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Introduction. En l'état actuel des connaissances, les études comparatives de *Posidonia oceanica* (L.) Delile dont nous disposons concernent surtout la phénologie et la biométrie des feuilles (OTT, 1980; PANAYOTIDIS et GIRAUD, 1981; WITTMAN *et al.*, 1981; BAY, 1984; PERGENT et PERGENT-MARTINI, 1988).

En ce qui concerne l'anatomie de *Posidonia oceanica* (rhizomes, gaines et feuilles), en dehors de travaux assez complets mais très anciens (SAUVAGEAU,1891; POTTIER, 1934), les seules études récentes, mais malheureusement partielles, sont celles de MARIANI *et al.*, (1980), COLOMBO *et al.* (1983), CROUZET (1984).

Quant à la caryologie, on ne recense que peu de travaux (CONTANDRIOPOULOS et VERLAQUE, 1984; HARTOG DEN *et al.*, 1987).

L'étude des herbiers à *P. oceanica*, à La Marsa, nous a permis de mettre en évidence, une population caractérisée, en particulier, par des feuilles plus larges que celles de *P. oceanica* des côtes françaises.

Les résultats de cette étude ont fait l'objet d'un travail plus détaillé (SEMROUD *et al.*, sous presse).

Résultats et discussion. La comparaison des histogrammes de fréquence de la largeur des feuilles adultes montre que les modes sont bien distincts quelle que soit la saison. Il se situe dans la classe des 10 mm à Port-Cros et celles des 11 ou 12 mm à La Marsa. Des variations de la largeur moyenne des feuilles chez *P. oceanica* ont été indiquées par plusieurs auteurs. PERGENT (1987) mentionne que la largeur des limbes adultes en fin de croissance fluctue avec la saison, la profondeur et la localité. Ces variations incomberaient, selon cet auteur, aux conditions d'éclairement. CAYE (1989), en revanche, pense que ces modifications sont probablement d'origine génétique.

Malgré, un nombre chromosomique diploide de 2n=20, commum à tous les représentants du genre (CONTANDRIOPOULOS et VERLAQUE, 1984; HARTOG DEN *et al.*,1987; KUO *et al.*, 1990), la comparaison des caryotypes met en évidence des différences significatives entre les populations du nord de la Méditerranée occidentale et celle de La Marsa, notamment en ce qui concerne les dimensions des chromosomes (plus importantes à Lâ Marsa), la position des satellites et celle des centromères.

Il apparaît que l'anatomie et l'histologie des gaines des feuilles de la population de La Marsa diffèrent par de nombreux paramètres des données classiques sur *P. oceanica* (confirmées par l'étude du matériel de Port-Cros), notamment par la forme et les dimensions, en coupe transversale, des cellules épidermiques, par la forme et l'épaisseur de la paroi des fibres, ainsi que par le nombre de nervures (19-21 au lieu de 13-17) (écart présent également dans le limbe : 15-17 nervures à La Marsa contre 14-15 à Port-Cros).

Conclusion. La rareté de la reproduction sexuée (au moins dans le bassin Nord-Occidental) chez *P. oceanica*, l'isolement de certaines populations, dû à la géographie compliquée et cloisonnée de la Méditerranée, peuvent laisser supposer que des taxons distincts pourraient s'être différenciés localement dans plusieurs bassins. Compte tenu de l'ancienneté du genre (STOCKMANS, 1932) et de l'histoire très perturbée de la Méditerranée au cours des temps géologiques, il semble assez probable que des phénomènes de spéciation ou de différenciation aient pu s'y dérouler, et se poursuivre même actuellement grâce à une dérive génique.

La découverte dans la région d'Alger, d'une population de *Posidonia* nettement individualisée par rapport à la description classique de l'espèce *P. oceanica* confirme que le genre *Posidonia* en Méditerranée n'est pas aussi homogène qu'on a pu le penser jusqu'à ce jour. Cette notable différenciation de *Posidonia oceanica* de Méditerranée (jusqu'ici insoupçonnée) peut être mise en parallèle avec le phénomène de spéciation très important qui affecte le genre *Posidonia* en Australie où huit espèces sont aujourd'hui distinguées (KUO et McCOMB, 1989).

Pour le moment, il nous paraît prématuré de statuer sur la position taxonomique de la population de La Marsa par rapport au concept classique de l'espèce *P. oceanica*. Il est certain qu'une éventuelle floraison de cette population serait susceptible de fournir de nouveaux éléments.

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Notes on the development and invertebrate colonization of *Sabellaria Alveolata* reefs in N/W Sicily

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Either the sudden outburst of a peculiar benthic community or its elimination are evidence of major changes occurring in the coastal environment of the Mediterranean Basin. Increase in eutrophication and mismanagement in most coastal biotopes of Sicily have resulted in massive growths of filter feeders and fouling-like biotic assemblages. Replacement of extant littoral photophilous algal communities by extensive mussel beds and/or other filter feeders has occurred since the end of the '70ies in the Gulf of Castellammare, western Sicily, as a consequence of the massive disposal of rough sewage and nutrient-rich sludge by an industrial plant for the treatment of vines (RIGGIO *et al.*, in press). They added up to the organic burden of the littoral waters due to the outfalls of some polluted streams, to the sewers of small and medium-size coastal towns and holiday resorts as well. As a result the **BODs** and **COD** of nearshore waters in proximity of the outlets have risen respectively to as much as **18.000mgl-1 and 24.000mgl-1** (CALVO and GENCHI, 1989). These values decrease according to an E-W gradient of dispersion. An outburst of the Polychaetous worm *Sabellaria alveolata* was recorded together with the spreading of *Mytilus galloprovincialis* beds, that in a few years gave rise to a long series of reefs parallel to the coastside in the most polluted portion of the gulf. The *Sabellaria* colonies protrude from the soft bottom as mushroom-shaped or reef-like outcrops rooted to rocky boulders ("hermelles", *sensu* GRUET, 1969-70; 1988); in this last case they can grow as high as 3m and as broad as 2m, by far exceeding the size reported in mid Tyrrhenian (TARAMELLI RIVOSECCCHI, 1961) or elsewhere in the Mediterranean. These bioconstructions range ca. 2km west of the most polluting outfall becoming smaller and more loosely aggregated as far as the pollution decreases.

Three sites (stat **1H, 2H, 3H**) were chosen along an E/W transect in the course of a survey of the "hermelles" and their biotic communities. Station **1H**, highly polluted, is near the outfall of Nocella creek ; **stat. 2H** is less polluted, however heavily affected by silting ; station **3H** is in nearly clean waters, with the Sabellarian colonies growing together with *Posidonia oceanica* and tightly intermingled to the seagrasses. Standard 8dm^3 cubes were sampled from the "hermelles" at the depth of ca. 1.5m. Samplings had a seasonal periodicity. Population densities, individual sizes and humid weights of the worms were recorded. The invertebrates inhabiting the sandy reefs were sorted out, counted and taxonomically determined.

As many as **13.190** individuals of S. *alveolata* were hand sorted in a total volume of **98dm^3**, resulting in a density of **1096 individuals/dm^3**. The following mean densities were recorded : stat. **1H = 1295** ± 340.4 indiv./dm^3 ; **2H = 1037** ± 100.4/dm^3 ; **3H = 965** ± 220.9/dm^3. Mean humid weights of the worms were : **54.36g ± 7.76 at 1H ; 30.92 ± 10.99 at 2H ; 33.7 ± 14.18 at 3H**. The Crustacea were 69.4% of the total invertebrate population inhabiting the reefs : 12% were Decapoda mainly represented by the genus *Alpheus*. Higher abundances were recorded at stat. **3H** . The 88% Peracarida were subdivided into : 4.8% Isopoda ; 15.2% Tanaidacea ; 68% Amphipoda. This last group was much more frequent at stat. **2H**, whereas the Tanaidacea were most frequent at **3H**. The Amphipoda *Maera inaequipes* with as many as 262 individuals and *Corophium acutum* with 189 were dominant, however unequally distributed. C. *acutum*, a typical component of harbour fouling, was mostly found at stat. **1H** ; *M. inaequipes* was instead more abundant at 3H. *Jassa marmorata* was concentrated at **3H**, with 70 individuals. The Tanaidacea *Leptochelia savignyi* and *Apseudes* spp. were recorded during the autumn - winter and were complementary to the Amphipoda whose presence was restricted to spring and summer. *Cyathura sp.* was the most frequent Isopod exclusive of stat. **2H**. As many as **657 molluscan** individuals were counted, **64% Bivalvia** and **36 % Gastropoda.** The **Opistobranchia** were found only at stat. **3H**, where their presence was as high as **10 %**. The **Bivalvia** were by far more abundant at stat. **1H** in mid- and late summer : *Mytilaster minimus* carpeted the reef surfaces, associated to *Mytilus galloprovincialis*, *Musculus subpictus*, *Gregariella opifex* and *Ostrea edulis*. All these species are dependent on the high organic content and the massive loads of particulate matter dumped on the seaside. *Thais haemastoma* and other dominant scavengers are indicators of a heavy environmental disturbance. Burrowing and suspensivorous taxa as *Lima lima*, *Lopha steantina* and *Anomia ephippium*, closely related to sandy concretions, were exclusively found at stat. **2H**. Their abundance should be interpreted as a recovery from the dystrofication of **1H**. This observation was further enhanced by the high diversity of the Gastropoda, dominated by *Hinia incrassata*, *Columbella rustica* and *Pisania sp.* The molluscan populations of **3H** were typical of *Posidonia* meadows, with *Tricolia pullus*, *T. speciosa*, *Alvania* spp. and *Turbona* spp. as the most representative taxa. The above picture does not change when the Polychaete component was taken into account. *Nereis falsa*, *Capitella capitata* and other taxa related to anoxyc reducing conditions in a sediment-rich bottom characterized stat. **1H**. Syllidae and Phyllodocidae -typical of cleaner waters- were instead dominant at stat. **2H**. The exclusive presence at stat. **3H** of carnivorous Aphroditids and Glyceridae was evidence of environmental recovery (Figs. 1, a; b).

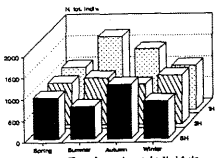

Fig. 1a - Trend numbers individuals *Sabellaria alveolata*

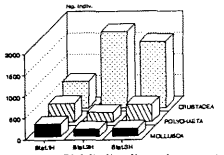

Fig. 1b - Distribution the major groups

As a conclusion, the outburst and rapid expansion of *Sabellaria alveolata* reef-like colonies is an effective means of the coastal environment to convert and temporarily store surplus waste energy, and ultimately have a stabilizing effect on the ecosystem. The "hermelles" are a major refuge to invertebrates and a source of food for the fish, thereby locally increasing the diversity. The structure and composition of the fauna associated to the worms are a reliable spotty indicator of a whole set of environmental conditions, that range from those favouring the settlement of fouling assemblages to those supporting communities adapted to a moderate eutrophication. Availability of seston and grain-size of sands are however crucial. The changes now occurring in the coast of Sicily, are likely to give a clue to a better understanding of some biotic processes that have been developing in the past in other parts of the Mediterranean coastal system causing its present features.

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Grain size and amphipod distribution in the North Aegean Sea

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Amphipods, in spite of their important role in the benthic ecosystem, are very little studied in the Greek seas. Furthermore, several studies have implicated grain size as an important determinant of amphipod distribution (FINCHAM 1973, etc.), although other authors (e.g. ROBERTSON *et al.*, 1989) consider factors like organic carbon as more important.

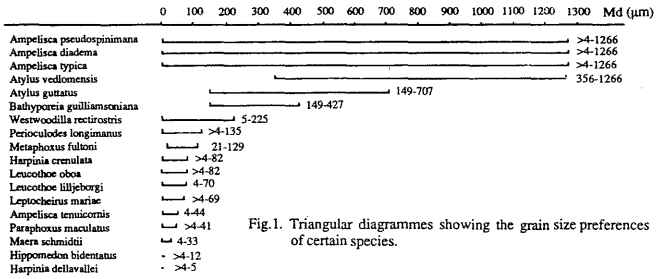
The present paper deals with the relationship between the grain size and the distribution of the amphipods collected during benthic surveys in the North Aegean Sea Samplings were made in three gulfs (Thermaikos, Strymonikos and Kavala), either using a Charcot-Picard dredge, or a Van Veen grab, in 180 stations, at depths of 0.9 to 86.4 m, in soft substrata. Certain physico-chemical parameters were measured. Particle size analysis was conducted combining dry shieving of the sand fraction and pipette analysis of the silt-clay fraction, as described by BUCHANAN (1984).

119 amphipod species were totally found in the three gulfs (71 in Thermaikos, 58 in Strymonikos and 59 in Kavala). The most widely distributed are the 18 species given in Table I. In this table, the fluctuation of the Median diameter (Md) of the sediment in which each of these species was found is presented.

The preferences of the various species concerning the grain size of the sediment are much better illustrated in the triangular diagrammes of Fig. 1. In these diagrammes, the sampling stations in which each amphipod species was found, are set depending on the clay-silt-sand fractions. In the present paper, only representative diagrammes are given, for 8 of the most widely distributed species in the three gulfs.

As indicated in the above diagrammes, three basic groups of amphipod species are distinguised. The first group includes species that occur in almost the whole range of sediment types, according to our data. In this group the species of the genus *Ampelisca*, *A. pseudospinimana* BELLAN-SANTINI & KAIM-MALKA and *A. diadema* (A. COSTA) are included, which, however, seem to have a slight preference in silty sediments (Fig. 1). The second group comprises of species preferring substrata with relatively big grain diameter, for example the species of the genus *Atylus*, *A. guttatus* (A. COSTA) and *A. vedlomensis* (BATE & WESTWOOD) which appear in stations where the sand fraction is greater than 75%. The third group includes species showing a preference in sediments with small grain diameter (mainly silty or clay-silty), having for this reason a very limited range of distribution. Such species are *Maera schmidtii* STEPHENSEN, *Leucothoe oboa* KARAMAN and *Hippomedon bidentatus* CHEVREUX. Finally, *Metaphoxus fultoni* (SCOTT) seems to prefer sand-silty sediments.

Table I. Median diameter (Md) fluctuation for certain amphipod species.



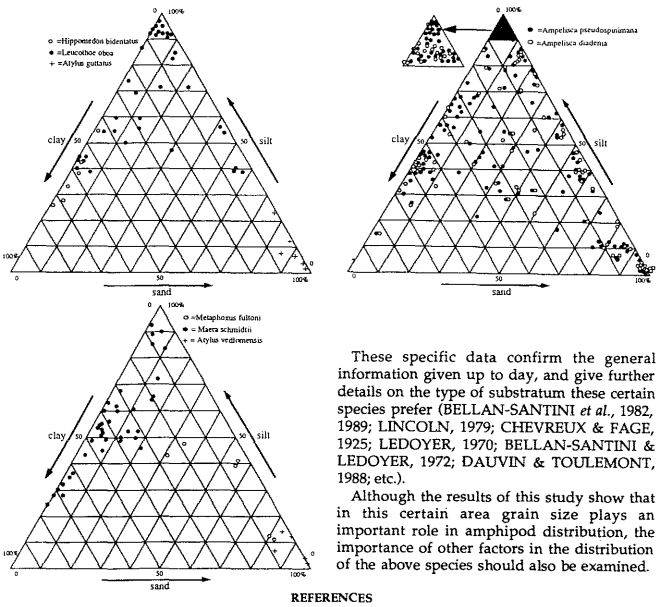


Fig.1. Triangular diagrammes showing the grain size preferences of certain species.

These specific data confirm the general information given up to day, and give further details on the type of substratum these certain species prefer (BELLAN-SANTINI *et al.*, 1982, 1989; LINCOLN, 1979; CHEVREUX & FAGE, 1925; LEDOYER, 1970; BELLAN-SANTINI & LEDOYER, 1972; DAUVIN & TOULEMONT, 1988; etc.).

Although the results of this study show that in this certain area grain size plays an important role in amphipod distribution, the importance of other factors in the distribution of the above species should also be examined.

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B

Etat des populations de quelques espèces de Bivalves du Littoral Roumain de Mer Noire

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Dans les conditions où les communautés benthiques du nord-ouest de la mer Noire sont toujours plus dégradées à la suite du phénomène devenu chronique de la mortalité en masse du zoobenthos (3, 4, 5), à peine peut-on parler d'espèces de bivalves réellement de masse, donc, dans le présent travail nous allons passer en revue quatre espèces de bivalves, soit très abondantes auparavant et caractéristiques de certaines biocénoses - *Corbula mediterranea* Costa, *Cardium edule lamarcki* Reeve, *Mytilus galloprovincialis* Lam. -, soit dominantes à présent de point de vue quantitatif dans le macrobenthos - *Mya arenaria* L.

Pour la connaissance de l'état des populations de ces espèces, on a analysé des échantillons provenus d'un réseau de 33 stations dans la zone nord du littoral roumain (entre Sulina et Constantza), aux profondeurs de 5, 10, 20, 30, 40 et 50 m, pendant les années 1990-1991. En vue de quelques comparaisons, on a utilisé aussi les données de la période 1980-1938.

Corbula mediterranea, par sa présence, caractérisait la zone des sables fins des profondeurs 0-20 m. Il y a 27 ans, le bivalve y était omniprésent et dominait comme densité et biomasse dans le cadre du macrobenthos (1). En 1990, sa fréquence à 0-20 m était de 44 %, les moyennes de densité et biomasse étant respectivement de 159 ex/m^2 et 5,2 g/m^2. Au cours de l'année 1991, la fréquence a diminué jusqu'à 22 % tandis que la densité et la biomasse n'enregistraient que 10 ex/m^2 et respectivement 1 g/m^2 (valeurs moyennes). Ces données, à côté de celles des années antérieures, prouvent le grave déclin des peuplements de *C. mediterranea*. La fréquence de l'espèce était 100 % en 1965, 88 % en 1983, 76 % en 1986 et 53 % en 1987, tandis que les densités et les biomasses moyennes ont diminué de 21000 ex/m^2 et respectivement 200 g/m^2 en 1965, à 4500 ex/m^2 et 80 g/m^2 en 1987 et ensuite aux valeurs mentionnées plus haut pour les années 1990 et 1991. Espèce caractéristique de la biocénose, et donc à strictes préférences écologiques, *C. mediterranea* est devenue, d'une espèce de masse, une espèce menacée par la disparition.

Cardium edule lamarcki est l'une des espèces associées aux sables à *Corbula* (0-20 m de profondeur), étant répandue elle aussi, mais en quantités plus petites, jusqu'à une profondeur de 40-50 m. Quant aux profondeurs de 0-20 m, la fréquence de l'espèce a été 55 % en 1990 et 16 % en 1991, sa densité moyenne de respectivement 83 ex/m^2 et 15 ex/m^2, et sa biomasse de 63 g/m^2 et 8,3 g/m^2. Remarquons aussi dans le cas de ce bivalve une diminution quantitative considérable en 1991, ainsi qu'une distribution très hétérogène.

Mytilus galloprovincialis du substrat sédimentaire caractérise la vaste biocénose pontique des moules des vases, dont l'aire typique sont les vases des profondeurs de 30-50 m. La fréquence de l'espèce aux profondeurs de 10-50 m a été de 60 % en 1990 et 42 % en 1991. Le densités et les biomasses moyennes des deux années ont été assez proches : 201-300 ex/m^2 et 129-150 g/m^2. La distribution actuelle des peuplements de *Mytilus* est caractérisée par les plus abondantes populations à 20m (en moyenne 1086 ex/m^2 et 465 g/m^2) et non pas à 30-50 m (58 ex/m^2 et 56 g/m^2) situation entièrement différente de la période antérieure (1984-1988), quand les moules étaient peu fréquentes à la profondeur de 20 m, et en petites quantités (environ 45 ex/m^2 et 16 g/m^2). Donc, les peuplements de ce bivalve se sont rapprochés de la côte, à des profondeurs plus faibles. Les raisons de ce phénomène sont multiples, un rôle important ayant ici le changement de la qualité du substrat. Dans l'ensemble, les quantités de moules se sont réduites (il y a 15-25 ans les densités pouvaient atteindre quelques milliers d'exemplaires par m^2, et les biomasses 1-2 kg/m^2), même si l'on enregistre des augmentations dans la zone étroite de 20 m de profondeur.

Mya arenaria, acclimatée assez récemment en mer Noire, signalée sur notre littoral depuis 1967, a intensément proliféré pendant les années suivantes; ses peuplements se sont installés ainsi sur substrat sableux que sur celui vaseux, jusqu'à 30 et même 40 m de profondeur. Espèce opportuniste, elle fut favorisée par le renforcement de l'eutrophisation au cours des premières années d'expansion (1970-1975) quand ses densités et biomasses dépassèrent par ailleurs 6000 ex/m^2 et 3 kg/m^2 (2). Dans les années suivantes, malgré les grandes variations des effectifs de ses peuplements - affectés de temps en temps par des mortalités - l' spèce a été toujours largement répandue sur notre littoral, dominant la biomasse du zoobenthos des profondeurs allant de 0 à 30 m. En 1990, *Mya* avait une fréquence de 85 %, et en 1991 de 55 %. Les moyennes de la densité étaient de respectivement 518 ex/m^2 et 404 ex/m^2, et celles de la biomasse de 321 g/m^2 et 262 g/m^2. La distribution des populations a été très hétérogène. En dépit des grandes pertes de populations de *Mya* au cours des années à fortes floraisons suivies d'hypoxie, l'espèce domine toujours comme biomasse le zoobenthos, dû à son haut degré d'opportunisme et à sa grande capacité de régénération.

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Evolution des populations de certaines espèces de masse de Polychètes de la Zone Marine Roumaine

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Ce travail présente les résultats de nos recherches des années 1990 et 1991 dans la zone Nord du littoral roumain, entre Sulina et Constanta (33 stations aux profondeurs de 5, 10, 20, 30, 40 et 50 m). les espèces de polychètes dignes d'être considérées espèces de masse par les densités atteintes en certaines périodes sont : *Spio filicornis* (O.F.M.), *Neanthes succinea* Leuck., *Polydora limicola* Annenk. et *Melinna palmata* Grube (1, 2, 3). Nous présentons dans ce qui suit les principales conclusions sur l'état actuel des populations de ces espèces.

Spio filicornis constituait la seconde espèce dominante de la biocénose des sables à *Corbula mediterranea*, avec une fréquence de 100%. Au cours des années 1960-1965 jusqu'à ces dernières 5-7 années, ses densités comptaient des milliers d'exemplaires par m2. Parmi les polychètes, l'espèce constituait 60-95% de la densité et quelquefois même 100% (populations pures) (1).

Pendant les années 1990 et 1991, la fréquence de l'espèce dans la zone de 0-20 m de profondeur a été de seulement 39-42%, à la suite de sa disparition en certaines zones; ses densités, très réduites, dans les stations où l'on a identifié l'espèce, ont oscillé entre 10 et 230 ex/m2, la moyenne de la densité pour les deux années étant de 142 et 70 ex/m2. ces valeurs indiquent un grave déclin des populations de cette espèce caractéristique de la biocénose, pouvant laisser supposer que l'espèce est menacée de disparition.

Neanthes succinea, considérée espèce tolérante, a beaucoup proliféré au cours cette dernière dizaine d'années, parallèlement à l'eutrophisation du milieu marin. Si l'espèce était plutôt rare dans la période 1960-1965, en 1984-1988 sa fréquence était de 90-100% aux profondeurs de 0-20 m. En 1990, la fréquence de ce polychète fut de 83%, et en 1991 de 52%. Quant à l'évolution des populations de cette espèce, la prolifération de la période 1983-1986 a donné des densités de 4000 ex/m2, tandis qu'en 1990 la densité moyenne était de 620 ex/m2 et en 1991 de 129 ex/m2.

Polydora limicola est elle aussi une espèce tolérante, apparue et a proliféré sur le substrat sédimentaire des profondeurs de 0-50 m lors de l'augmentation du degré d'eutrophisation.

L'évolution quantitative des peuplements de cette espèce est semblable à celle de *N. succinea*, c'est-à-dire, après une période de prolifération intense durant la période 1983-1986, avec des fréquences de 80-90% et des densités moyennes de 6000-22000 ex/m2, a eu lieu une diminution intense de la fréquence (63% en 1990 et 55% en 1991) et de son effectif jusqu'à une moyenne de 200-300 ex/m2 ces deux dernières années.

Melinna palmata, espèce rare il y a 27 ans sur le littoral roumain, a connu depuis 1975 en raison de l'augmentation de substances organiques en mer et dans le substrat, un prolifération explosive, avec des moyennes de la densité de 2800 ex/m2 et des maxima dépassant 17000 ex/m2. Pendant les dernières 5-6 années, en dépit de leur présence presque constante (fréquence au-dessus de 80% à 20-40 m de profondeur), ses populations ont connu une diminution quantitative, les densités moyennes des années 1990 et 1991 étant de 410-680 ex/m2.

Les phénomènes de floraison devenus chroniques, l'installation de l'hypoxie et même de l'anoxie, ainsi que les mortalités en masse du zoobenthos qui s'ensuivent, ont déterminé une telle dégradation du milieu marin, que qui indique un grave déséquilibre écologique écologique des communautés benthiques.

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Distribution et répartition verticale des bryozoaires fossiles dans les sédiments du sud du Bosphore et de la Corne d'Or et leurs implications paléoécologiques

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Systématique

Avant cette recherche aucune autre n'avait été effectuée sur les bryozoaires fossiles existants dans les sédiments du Bosphore et de la Corne d'Or. En revanche, les bryozoaires actuels de toutes les mers de Turquie ont été étudiés par UNSAL, (1975) et UNSAL et d'HONDT(1978-1979). En vue d'obtenir le matériel de recherche, on a pratiqué 19 sondages dont 17 en milieu marin et 2 en milieu terrestre (Fig. 1), Numéros de sondages : 16, 17). on a prélevé des échantillons des différentes profondeurs juqu'à 80 mètres. Dans 12 (Fig. 2) de ces 19 sondages, nous avons relevé des bryozoaires fossiles dans la partie supérieure des sédiments (jusqu'à un maximum de 32 m). Au total, on a trouvé 12 espèces appartenant à 10 genres (Tab. 1). Les espèces fossiles retrouvées sont présentes aussi dans la faune actuelle des mers de Turquie sauf *Tricellaria peachii*.

Paléoécologie

En considérant la répartition verticale des espèces dans les sédiments de la Corne d'Or et du Bosphore, les premiers 20-25 mètres, à partir de la base des sédiments, ne contiennent pas de bryozoaires. Cela met en évidence que cette région n'était pas au début de caractère spécifiquement marin. *Electra crustulenta* est une forme vivant dans des eaux de salinité abaissée (13.7‰ - 27.3‰) RYLAND et HAYWARD (1977). En outre nous savons que *Electra crustulenta* ne vit que dans la Mer Noire (UNSAL, 1975). Par conséquent, la découverte de cette espèce dans le sondage numéro 7 pratiqué dans la Corne d'Or, et dans les sondages 119 et 120 pratiqués dans le Bosphore (Sarayburnu - Usküdar) prouve que la région subit de temps à autre l'effet des eaux de la Mer noire. Les formes *Crisia denticulata, Cellaria salicornioides, Hippopodinella lata, Lagenipora lepralioides, Schizoporella unicornis, Scrupocellaria scruposa* sont les représentants des eaux de salinité normale (GAUTIER, 1962). La découverte de ces formes dans les strates supérieures des sondages numéros 114 et 119 pratiqués dans le Bosphore, met en évidence l'existence, dans le passé, d'un milieu plus salé que la corne d'Or et montre que la région subit l'effet des eaux d'origine méditerranéenne. Par conséquent cette région a été habitée par une faune à bryozoaires formée d'espèces adaptées à ces circonstances. Cette région du Bosphore, 9 500-7 000 ans avant notre ère, a subi de temps à autre l'effet des eaux méditerranéennes de salinité normale (STANLEY et BLANPIED, 1980). On a déterminé par la méthode Electro Spine Rezonans (ESR) l'âge absolu des sédiments du Bosphore, lequel est de 7 400 ± 1 300 ans. La première influence marine commence aux moments sus-indiqués (TANER *et al.*, 1991).

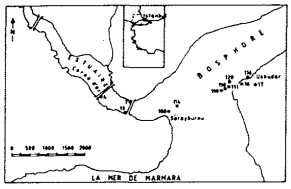

Figure 1. Numéros des sondages

LES ESPECES	ESTUAIRE (Corne d'or)			BOSPHORE (Sarayburnu-Usküdar)								
	6	13	7	106	108	111	114	116	119	120	16	17
Crisia denticulata (Lamarck 1816)							X					
Crisia aburnea (Linnaeus 1758)		X	X	X			X		X			
Crisidia cornuta (Linnaeus 1758)							X					
Cellaria salicornioides Lamouroux 1816		X	X				X					
Cryptosula pallasiana (Moll 1803)		X	X	X		X	X	X	X	X	X	X
Electra crustulenta (Pallas 1766)			X						X	X		
Electra monostachys (Bush 1854)				X					X			
Hippopodinella lata (Bush 1854)									X			
Lagenipora lepralioides (Harmer 1868)							X					
Schizoporella unicornis (Johnston 1847)					X				X			
Scrupocellaria scruposa (Linnaeus 1758)	X	X	X				X		X			
Tricellaria peachii (Bush 1851)		X	X	X								

Tableau 1. Liste des espèces.

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Some results on Echinoderms and Crustacea Decapoda studies of the Albanian Coast

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1. The Albanian coast amounts to 470 km long. It is washed by the Ionian Sea and Adriatic Sea (Southern Adriatic). The Adriatic part spreads in a N-S direction and from a geomorphological point of view it is shallow, generally accumulative, with a lot of sandy beaches, wetlands, and lagoons. Almost all the Albanian rivers, carrying a large amont of silt and gravel, end up in it. The Ionian part which spreads in a NW-SE direction is a high rocky coast, generally abrasive. It is known for its great depth (HIDROLOGJIA E SHQIPERISE, 1984).

From a zoogeographycal point of view, the Albanian coast represents a special interest since it is situated in the border of two subregions: the Western and Eastern Mediterranean (STEVCIC, 1983).

It results that the Albanian coast is one of the less investigated in the Mediterranean basin (STEVCIC, 1990; TORTONESE, 1965; ZARIQUIEY ALVAREZ, 1968).

A small team of albanian scientists has been involved in the faunistic study of some benthonic graups during the last 20 years (Echinoderms, Crustacea Decapoda, Molluscs, Benthonic Fishes). Some of results obtained up to now on Echinoderms and Crustacea Decapoda will be presented below (GJIKNURI, 1985, 1986; GJIKNURI and VASO, 1991; VASO, 1991).

2. The area investigated is located mainly in the continental platform. The material was collected depending on the depht and the type of bottom. In the shallow water it was collected by hand and by diving, in the open sea it was collected with a commercial trawler of 400 HP and with a bottom-trawl net. Rocky bottoms deeper than 40 m and the meadows with *Posidonia oceanica* have not been explored. The collected material has been deposited at the Museum of Natural Sciences in Tirana.

3. The presence of 46 species of Echinoderms belonging to the classes of Crinoidea (2), Asteroida (17), Ophiuroidea (6), Echinoidea (12), Holothuroidea (9) and 104 species of Crustacea Decapoda belonging to the sections Penaeidea (11), Caridea (19), Macrura Reptantia (13), Anomura (20) and Brachyura (41) has been recorded up to now in the Albanian coast.

About 63% of Echinoderms and 58% of Crustacea Decapoda belong to soft bottoms, respectively about 15% and 18% to hard bottoms and about 22% and 23% to soft - hard bottoms.

The dominating element from a zoogeographical point of view results the atlantic - mediterranean one, to wich belong 65% of Echinoderms and 63% of Crustacea Decapoda. Then follow the mediterranean endemic element respectively 13% and 12%, the thermophyl one with 13% and 12%, the boreal one with 7% and 9% and the widely spread one with respectively 2% and 4%.

Especially interesting from a faunistic point of view is the presence in all the Ionian coast of the thermophyl starfish *Ophidiaster ophidianus* and also the presence of the sea cucumber *Holothuria helleri* (Fig.1), data which contribute in the general distribution of the species in the Mediterranean Sea.

These data do not mean that the study of Echinoderms and Crustacea Decapoda in the Albanian coast is accomplished. These studies are still in progress.

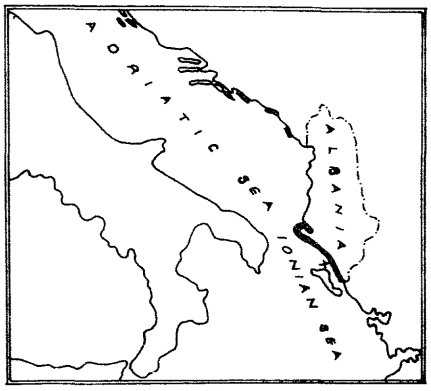

Fig. 1. Distribution of Ophidiaster ophidianus (—) and Holothuria helleri (+)

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Study on a benthic community under the influence of waste warm water.
1 - Polychaeta, Anisopoda, Isopoda, Amphipoda, Echinodermata

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Among the studies on the effects of pollutants on marine ecosystems, little information is available about the influence of thermic pollution on benthic communities. BELLAN-SANTINI and DESROSIERS (1977) investigated a Mediterranean area affected by strong industrial pollution in addition to a thermic one; BONVICINI PAGLIAI *et al.*, (1979) carried out a qualitative analysis of the macrozoobenthos near the power plant this paper refers to.

This research was performed in order to investigate the influence of power plant waste warm water on the marine benthic community near the Torre Valdaliga Nord power station (Civitavecchia, Italy), in the eastern part of central Tyrrhenian Sea. The station has a peak power of 2640 MW; it gives back up to 90 cubic metres per second of water 8°C warmer.

Sampling was carried out in spring and autumn 1989. Two areas were chosen : the shallow water (as far deep as 2 m) bottom along the coast at both sides of the drain canal, and the area off the power plant, centred on the drain canal (Fig. 1). The latter was divided into 30 sectors; in each sector a station-point was located. In the aim of comparing homologous coenotic units, all the sampling sites of both areas were placed on the *Corallina* spp. *facies*, very important in that part of the coast, characteristic of the AP *(Algues Photophiles)* biocoenosis; furthermore, the shallow water stations had the same exposure. An area of 0.4 square meters (20x20 cm) was scraped in each station.

The study of *Polychaeta, Anisopoda, Isopoda, Amphipoda,* and *Echinodermata* syntaxa was performed both by descriptive and statistical analysis, the latter by ordination techniques (FAC, Factorial Analysis of Correspondences).

A very homogeneous distribution arises from the data, both in the shallow water sample area (Fig. 2 and 3) and in the off shore grid stations (Fig. 4 and 5), in spring (Fig. 2 and 4) as well as in autumn (Fig. 3 and 5). The sole particularity in the peuplements' structure was found in spring in the group of shallow water stations about 500 m south-east of the drain canal (Fig. 1; Fig. 2). Species generally present in harbours and/or in other biotopes characterized by low hydrodynamic energy and moderate pollution *(Cirriformia tentaculata, Naineris laevigata, Protoaricia oerstedi, Jassa marmorata, Elasmopus* spp., *Dynamene edwardsi)* have high dominance values in those samples, where, moreover, lower H' values were recorded. Due to the prevailing NW current, this difference is not referable to thermic pollution, but probably to the proximity of the harbour of Civitavecchia.

The results seem to show that the benthic community is not directly affected by waste warm water; on the other side, the organic pollution from the harbour and from the city has a clear influence on the structure of the shallow water community. These data are consistent with the observations of BELLAN-SANTINI and DESROSIERS (1977) on the benthic community of the Gulf of Fos (France).

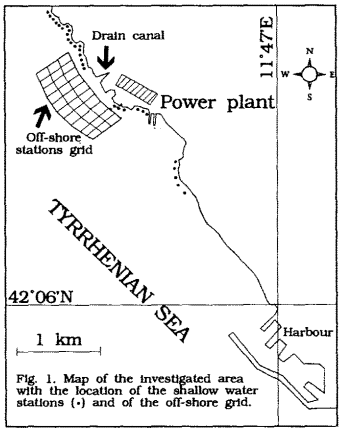
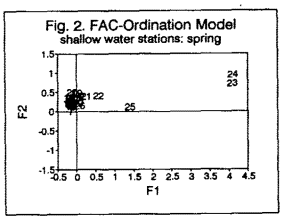
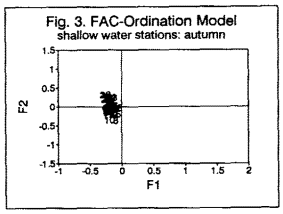
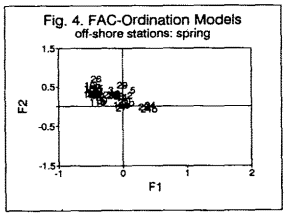
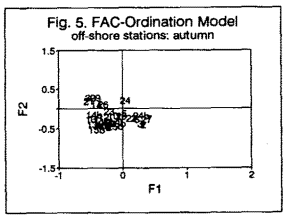


Fig. 1. Map of the investigated area with the location of the shallow water stations (•) and of the off-shore grid.









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Phosphorus fluxes in the Southeastern Mediterranean waters

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The consideration of phosphorus in the marine environment is due to its double existence sometimes as a pollutant and others as an important nutrient element. Elevated phosphorus concentrations cause eutrophication problems while phosphorus absence may be in most cases a limiting factor for biological production.

In the post High Dam period, the biological productivity of the S.E. Mediterranean has greatly declined due to the cessation of the Nile flood and the subsequent drop in the nutrients levels, especially phosphorus. The N:P ratio in the area is always over 20:1 indicating that phosphorus is a limiting nutrient in this basin. This peculiarity must be linked with physical and biological processes in the S.E. Levantine Basin. Direct current measurements are scarce and their use for water exchange is a complicated task due to existance of inshore counter currents and high variability due to wind. However, water circulation is a principal factor affecting the phosphorus cycle in the basin. Several biological and chemical transformations took place in the surface layer, while phosphorus is supposed to be more conservative in the intermediate and deep waters.

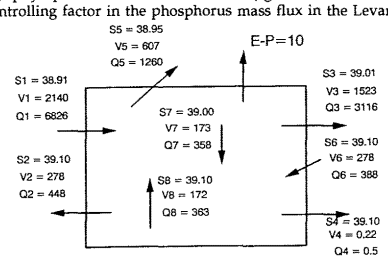
The present study is an attempt to compute the balance of phosphorus in the S.E. Mediterranean Basin based on the study of the movement of major water masses in the area. Data used in this study are a result of 10 oceanographic seasonal cruises carried out in the S.E. Mediterranean Basin during 1982/86, covering the area between longitudes 29°45′ E & 32°40′ E and extending over the continental shelf off the Egyptian coast. The geographical variations of salinity and temperature in this area were previously published by ABDEL-MOATI and SAID (1987). On the basis of water and salt budgets and in condition that there is no eustatic changes of bottom configuration, no fluctuations in sea level and that the bottom water layer has a more or less uniform thickness and depth, it is possible to write the mass balance equations:

$$V1+V6=V3+V4+V2+V5+(E-P);\quad V2+V4-V6=V7+V8;\quad \rho 2S2V2+\rho 4S4V4=\rho 6S6V6 \text{ and}$$

$$\rho 6S6V6-\rho 2S2V2-\rho 4S4V4=\rho 8S8V8-\rho 7S7V7 \text{ where } (E-P)= 10 \times 10^9 m^3 y^{-1} \text{ (see diagram).}$$

The coastal waters of the area receives about 16.1 X $10^9 m^3/y$ of fresh and brackish water from the different landbased sources. About 20% of this amount is discharged from the River Nile while the rest is being discharged through the Nile delta lakes. Through this route about 3371 T of phosphorus are conveyed yearly to the S.E. Mediterranean waters. About 32% of this amount is discharged from Lake Manzalah, the largest Nile delta lake, while about 26% is conveyed through the functioning branch of the Nile. Upon mixing with sea water, huge amounts of this discharge are lost through sedimentation in the coastal waters. This is evidenced from the remarkably low phosphorus concentrations (average 0.088 µM) observed at points located about 8 Km opposite to the major sources compared with 6 µM levels recorded near the hot discharge points. The contribution of rain water (3.4 X $10^9 m^3/y$) to the phosphorus balance is considered insignificant (about 4.2 T/y) compared to that discharged by landbased sources.

Phosphorus input and output fluxes due to water exchange, were calculated assuming that the phosphorus concentration observed in the western boundary is typical for the inflowing current while that of the eastern was characteristic for the outflowing current. The total phosphorus input to the S.E. Mediterranean Basin is 8589 T/y while the output reaches 4824 T/y, leading to a net gain of 3765 T/y. On the other hand, the standing stock of phosphorus in the basin is 3307 T. Of this amount 6% are present in the inshore waters (<20 m) while 44% and 50%, respectively, are present in the middle (20-100 m) and offshore waters (100-200 m). Between the input/output and the amount actually present, there is a surplus of 458 T of phosphorus. The difference between the calculated transport rates indicates a net loss from the water column. Comparing the estimated phosphorus recycled annually with the standing stock, it appears that the residence time of phosphorus is 0.4±0.1 y. Incorporation with biological cycles and/or further sedimentation could explain this imbalance. Vertical water movements create an important role in phosphorus cycling in the S.E. Mediterranean Basin. Differences in concentrations between surface and bottom layers leads to a net phosphorus transport of about 5 T through the thermocline layer by down and upward fluxes. The upward flux is nearly negligible during summer time due to the trapping of regenerated phosphorus in the bottom water below the picnocline. Using the formula of Hamilton-Taylor (1979) and an average sedimentation rate of 0.037 cm y^{-1} (ROSS & UCHUPI, 1977), the phosphorus sedimentary flux should be 61 T/y. The degree of accuracy of phosphorus loss depends on factors such as no organic phosphorus measurements were performed, particulate phosphorus data were not collected in continuous series and water circulation other than geostrophic were not considered. Based on insitu productivity measurements using labeled carbon-14 (DOWIDAR, 1984) the annual average primary production of the area was 55.5 g C $m^{-2}y^{-1}$ corresponding to 527 µg at C $m^{-2}h^{-1}$. Using Redfield ratio, the demand for phosphorus by phytoplankton amounted to 4.97 µg at P $m^{-2}h^{-1}$ indicating that biological activity is a controlling factor in the phosphorus mass flux in the Levantine Basin.



WATER AND PHOSPHORUS FLUXES IN THE S.E. MEDITERRANEAN

* V1 TO V8 in $10^9 m^3/y$ while Q1 TO Q8 in T/y

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Dissolved copper speciation in the coastal waters of Alexandria Region

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Speciation studies attempt to differentiate between the chemical forms and distribution of metal species in dissolved, colloidal and particulate phases. The distinction between dissolved and particulate forms by filtration through 0.45 µm is generally accepted. The dissolved fraction includes truly dissolved material plus colloidal fraction. Metals could also be classified according to their rate of reaction with a dissolved ligand as well as the extent of stability of their complex with this ligand. Metals bioavailability and biogeochemical cycles are influenced mainly by their interaction with dissolved organic matter which in turn is a reflection of the impact of man's activity on the environment.

The aim of the present study is to apply the cathodic stripping voltammetry (CSV) technique for the determination of dissolved copper species in several coastal marine environments differing in their exposure to the amount of metal discharged. The labile fraction of the metal is that species measured by CSV in untreated filtered sample including all inorganic complexes and a certain proportion of organically associated metal. The total dissolved metal is those species detected in U.V. irradiated (4 hours, 1 KW mercury lamp) and acidified (pH 2.5 ± 0.1) samples. This includes the summation of the metal present as free, inorganically complexed, organically complexed and colloidally associated metal species.

Samples were collected during low and high landbased sources discharge periods from three different locations covering the coastal waters of Alexandria region. These environments are subjected to agricultural, industrial and sewage runoff. Samples were collected in precleaned polyethylene bottles, filtered after collection by pressure and stored frozen between sampling and analysis. Analyses were carried out at pH 7.8 ± 0.4 using HEPES buffer and Oxine as a chelator (VAN den BERG, 1986). A PAR 174A Polarograph was used with a PAR 303A SMDE in conjunction with a Ag/AgCl reference and a platinum wire counter electrodes. Collection was performed at -1.0 V for 1 minute while scanning started from -0.3 V. Scanning parameters were : DPCSV, pulse rate 10 s , scan rate 10 mV s^{-1}, pulse amplitude 25 mV. The reduction current was recorded on a x-y recorder. Calibration was achieved using the standard addition technique. Additional analyses for salinity, DOC and TSM were made.

The average labile and total dissolved copper concentrations in the coastal waters of Alexandria, presented in Table 1, are higher than normal values expected in coastal waters. At the high salinity region i.e. offshore stations, labile Cu showed small changes (Figure 1). However, a significant increase in the non-labile Cu fraction was observed opposite to discharge points especially when salinity drops below 30 during high flow period. This increase coincided with the increase in DOC ($r= 0.8755$, $p< 0.001$) and suspended matter ($r= 0.7301$, $p< 0.01$) concentrations. Such a relation suggests the removal of Cu from solution through complexation by either organic matter and/or adsorption onto solids at the turbidity maximum zones. Agricultural rather than industrial and sewage discharges seemed to be the major source for dissolved Cu to the coastal waters. The use of copper sulphate in controlling algal blooms in the Nile delta lakes may be the possible explanation for this source. A high degree of copper complexation was observed at the dumping site for domestic and sewage discharge.

TABLE 1. Average labile and total Cu in Alexandria coastal waters.

Survey	Labile mean	Labile range	Total mean	Total range	Non-labile mean	Non-labile range
High flow	30±9	18.5-49.7	49±17	24.0-83.5	19±8	5.5-33.8
Low flow	15±8	6.5-34.1	20±11	9.0-40.2	5±3	2.5- 6.1

From the TDCu and salinity regression : TCu= -2.15 S+117.9 (high flow) and TCu= 0.0995 S+17.98 (low flow), the extrapolated TCu concentrations at salinity zero would be 118 and 18 nM for high and low flow periods, respectively. Such values are inconsistent with those reported at the Nile delta lakes-sea mixing zone i.e. 66 and 10 nM, respectively.

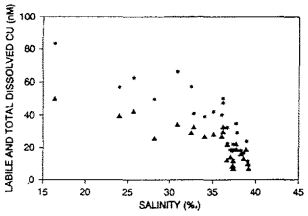

Figure 1. LCu and TCu vs. Salinity.

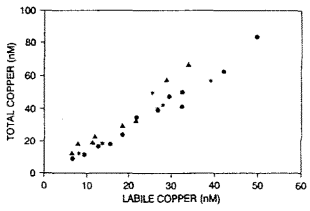

Figure 2. LCu against TCu.

The labile and total dissolved copper are linearly related (Figure 2). The LCu/TCu ratio was obtained for each zone from a plot of LCu values against those of TCu. The ratio ranged between 0.502+0.03 and 0.608+0.05. This ratio indicated that a range of 89 to 96.4% of the TDCu would be organically complexed. Such a value emphasize the importance of organic copper complexation in the coastal waters of Alexandria. Reported percentages of bound Cu of the total ranges from 30-50% (BATLEY & FLORENCE, 1976); 70-100% (SUGAI & HEALY, 1978); 94-98% (VAN den BERG, 1984) for coastal waters and <10-35% (DONAT *et al.*, 1986) for oceanic waters. The mean log α_{cul} determined in this study was 4.86±0.97, a value which is higher compared to previous studies ex: 3.14 for Irish Sea (VAN den BERG, 1984), 2.39-2.72 for Liverpool bay (NIMMO *et al.*, 1989) and 3.95 for Guanabara bay (VAN den BERG & REBELLO, 1986) indicating either high ligand concentration and/or high stability constant.

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A multivariate statistical approach to the interpretation of chemical analyses data from the Coastal Environment of Alexandria (Egypt)
1.- Q-Mode Factor Analysis and Partitioning Model by Linear Programing Technique

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During the period of 1985-1986, we have done a comprehensive research project to examine and assess the impact of sewage disposal on the chemistry of a heavily polluted South-Eastern Mediterranean basin, the Eastern Harbor (E.H) of Alexandria, Egypt. During the first phase of our research project, the main objectives were to investigate the consequences of sewage discharge on the water quality (ABOUL-KASSIM and DOWIDAR, 1990a,b), to construct the cycles of carbon (ABOUL-KASSIM, 1987; ABDEL-MOATI *et al.*, 1991), nitrogen (EL-NADY *et al.*, 1990) and phosphorus (DOWIDAR *et al.*, 1990), to fractionate the living biomass components of the harbor using adenosine triphosphate method (ABOUL-KASSIM *et al.*, 1992) and finally to study the composition of suspended matter (ABOUL-KASSIM, 1987). Our goal in the second phase of the project is to do a complete univariate and multivariate statistical analyses, just to reduce the big data set, to evaluate the pathways of pollutant transport, the regions of concentrations, and to identify some statistically significant end members; well representing the study area; and finally to conceptually computer model the environment of Alexandria.

When using the multivariate statistics approach for interpreting a chemical analyses data (ABOUL-KASSIM, 1992), there are three main goals when studying the distribution of pollution tracers in any sewage-impacted coastal environment. The first objective is to determine the number of significant systems which are contributing to the observed sample compositions. A system is defined as a source of the group of compounds studied (in our case; N, P & C species as well as some environmental parameters). One method of studying the nutrient composition of the marine environment is to inspect the concentrations of that fractions of all samples in an area in order to determine the number of systems present (Visual Pattern Recognition). A system is easily discerned if one or more samples contain a high proportion of that system and if the system's pattern is very different from the patterns of the other systems. Many times these conditions are not met because most samples are mixtures of many systems and it would be fertuitous that one sample would contain only one system. The second objective is to determine the chemical composition of the pure end member (the composition of a hypothetical sample containing 100% of one system). A major problem with the visual method is how far to extrapolate beyond the compositions of the sample richest in one system. The third objective is to determine the distribution of the systems in each sample. It is difficult to visually estimate how much of each system is in each sample except in gneral terms such as small, moderate or large amounts. So, in this paper, we will use **Q-Mode Factor Analysis** and **Partitioning by Linear Programing Technique** (LPT) just to:
1- identify specific end members in the marine environment of Alexandria harbor,
2- obtain the composition of the pure end members from factor scores,
3- construct the distribution of the systems within each sample from factor loadings.

Within this statistical approach, it is possible to assign the percentage contribution from various sources to the observed distribution of all chemical parameters in each sample.

Factor analysis has been recentally used in Environmental Chemistry (ABOUL-KASSIM, 1992), and very few studies have been done in the Mediterranean region (EL-SAYED *et al.*, 1988; FRIHY and GAMAI, 1991; GARDNER *et al.*, 1990). Q-Mode factor analysis technique is based on grouping a multivariate data set based on the data structure defined by the similarity between samples. By applying this fancy technique to our big data set, three significant principal factor loading scores were obtained, giving information about the sample variation of about 89.1%, 4.96% and 3.31%, respectively (maximum cumulative information of 97.37%).

The factor loading matrix which represent the sample representation in the model and indicated that the importance of each of the factors or end members in each sample (i.e. the better the model the closer the communality of the sample will be to 1.0). After varimax rotation of the composition scores, three significant end members were resulted, dominating by variables as salinity (S%.), total nitrogen (TN) and total suspended matter (TSM), respectively. A modification of Q-Mode factor analysis provides an objective means for end member routine. Factor analysis has not often been used to determine the actual composition of end member sources, because the transfer of the original data variables during the analysis result in negative factor scores for some variables and negative concentrations of some variables in the end members. Because of the orthogonality constraints, one vector must have negative contributions from one of the variables. This can be solved by using a non-orthogonal rotation of end member vectors, toward the mean vector to bring the end members into the positive vector space. To solve the partitioning model, a non-orthogonal end members were used by using a rotation called **oblique rotation**. By using the LPT, a set of equations were applied so as to correct the initial end member compositions and their abundance in samples so as to better fit the observed multivariate data set. This will help specify and select the composition of the end members, so that they are very close the true end members composition. Figure 1 shows the end member after partitioning by LPT. The importance of **salinity** as end member comes from the continuous dilution of the harbor water with low salinity domestic sewage as well as the continuous mixing of the harbor water with neritic Mediterranean water. These three significant end members are well describing the data set, indicating the important part played by sewage disposed to the bay with its important portions of TN and TSM (Figure 1).

An important conclusion concerning the application of factor analysis in our chemical analyses data is that the large amount of data is reduced to a very few systems "end members". This significant end members will be usefull to construct an environmental model in the near future work. The method of factor analysis is not limited to marine water samples and could be used to study rocks, gases as well as biological samples.

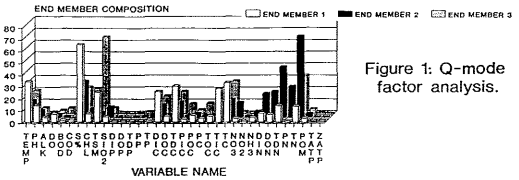

Figure 1: Q-mode factor analysis.

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A univariate statistical approach to the interpretation of chemical analyses data from the coastal environment of Alexandria (Egypt)
2- Analysis of Variance (ANOVA)

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Alexandria is the principal summer resort of Egypt. It is one of the relatively densel populated regions of the Eastern Mediterranean (about 3.5 million inhabitants receiving about 1 million tourists in summer who come to use its beaches fc recreation. Alexandria coastal waters are highly polluted with untreated domest sewage and waste waters, discharged into the sea through several outfalls along th coast, thus presenting a serious source of pollution in that region. In 1985-1986, research project has been done to assess the impact of sewage disposal on the wate quality of the Eastern Harbor of Alexandria. A necessary condition for any efficie water pollution study is the dominance of the inter sample concentration change over the intra sampling site dispersion. The repeated sampling of the water networ performed in the present study affords in principle a statistical differentiation betwee these two major causes of variation. The concentration changes can be studied terms of environmentally significant factors such as sewage influence, distance fro the source points, water depth and time of collection.

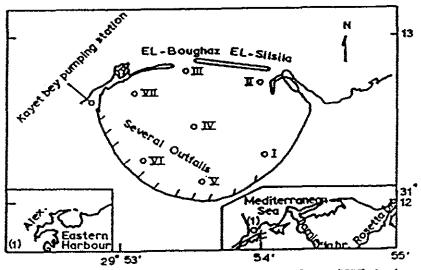

Fig. 1. Stations sampled in the Eastern Harbour (EH) during the period 1985–1986.

The study area (Eastern Harbor) is a shallow semi-closed basin (Figure 1), sheltere from the sea by an artificial break water leaving two openings through which th exchange of water between the harbor and the neritic Mediterranean water takes plac Our data set consists of 256 samples (cases) with 37 environmental parameter (variables) studied.

In this paper, we will use a powerful univariate statistical technique as ANOVA t analyze the inter/intra sample variation. The technique was performed to measur the significant difference between:
1- different stations,
2- different months, and
3- different water levels.

Based on the T-test (0.05) and F-test (0.05) values, the significant variables ONL have entered the program as dependent variables.

ANOVA between stations

The variables which recorded significant differences between stations are:
a- Transparency:
Stations III & IV (located near the entrance of the unpolluted Mediterranean wate recorded significant difference from stations VII & II as well as I, V, VI (located close t sewage disposal).
b- Salinity:
Significant difference in salinity occurred between stations (III & VII) and (I, V, VI).
c- Chlorophyll a:
Stations (V & I) recorded significant difference with (II, III, IV, VII).
d- Particulate organic carbon (POC):
Stations V varies with station IV, VII, III and station III differs from I, VI, V.
e- Nitrate:
Station I recorded significant difference with the other 6 stations.
f- Particulate organic matter (POM):
Stations I differs from III, IV and VII, while station V recorded significant differenc from stations III, IV.

ANOVA between different depths

Significant variations between surface (S) and bottom (B) water levels occurre between the following variables: O_2, S%, CHL A, DIP, DOC, POC, NO_3, DOP, PP, DO and PN were recorded. Most of the cases recorded insignificant difference betwee bottom (B) and middle (M) water levels.

ANOVA between different months

The following variables recorded significant differences between months: O_2, S% CHL, DIP, DOC, POC, NO_3, NO_2, DOP, PP, DON, DIC, PIC, NH_3, DON and PN. Month of the warm season including May, June, August and September recorde insignificant differences between themselves and significant differences with the othe months.

Conclusion

The significant differences recorded between stations located close to sewage outfall (I, V & VI) and the other stations are due to the effect of the domestic sewage dispos and its variability within the different stations. The significant difference betwee surface and bottom/middle water levels is due to the effect of mixing between the lo density sewage water with the surface water of the bay. The difference betwe summer season and the rest of the other months is coinciding with periods of hig sewage discharge rate in Alexandria city.

Flux of Phophorus and Nitrogen in a sewage-impacted coastal sediments of a South-Eastern Mediterranean Basin

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Introduction

In shallow coastal marine environments, there are good evidences that the bottom sediments play an important role in nutrients supply to the photic zone. Some workers estimated that the flux of nutrients from sediments may make up between 30% and 100% of nutrient requirements of the phytoplankton in the photic zone (ROWE *et al.*, 1975; HARGRAVE and CONNOLLY, 1978).

In this paper, our goal is to conduct laboratory experiments to study the flux of phosphorus and nitrogen (nitrate and ammonia) from the sewage-impacted sediments of the Eastern Harbor (E.H) of Alexandria and to calculate their contribution to the nutrients cycles in the study area.

Material and Method

The study area is a semi-circular shallow bay (Eastern Harbor), surrounded by Alexandria city, connected to the Mediterranean through two openings. The basin is subjected annually to about $35x10^6$ m^3 of unprocessed sewage, rendering its flushing time to be 5 months. Representative bottom sediment samples were collected from 3 stations in the Harbor basin. The flux of nutrients in the harbor basin was measured using two methods:

1- Calculating the flux using concentration gradients between constituents of interstitial water and overlying water column.

2- Measurement of the nutrient flux by laboratory experiments under static conditions. Following the method of HARGRAVE and CONNOLY (1978), a small portion of sea floor was cut out with some overlying water (2 liters) from the same stations and incubated in glass basins without disturbance under controlled conditions in the laboratory. For each station, the sediment sample was placed in three identical basins, two with sea water and the other with distilled water. Samples were taken from these basins above the sediments without disturbance at time intervals of 5 days for one month and analyzed. The flux (F) of dissolved material into or out of undisturbed sediments can be calculated as ug at/m^2/day, using the following equation:

$$F = \frac{V(Co - C_t)}{A} \times \frac{10^4}{T}$$

Where V: is the volume of water over the sediments (liters); Co & C_t: are the dissolved nutrient concentration (per liters) before and after time (T); A: is the sediments area (cm^2) enclosed. The experiment requires that the water be homogeneously mixed, that changes in concentration are known or assumed to be linear over time and that dissolved material is only exchanged at sediment surface.

Results and discussion

Results indicated that maximum phosphorus released from sediments was attainted during the first five days (Figure 1). An overall average of about 206 kg PO_4-P/Km^2 was estimated. In other words, 520 kg PO_4-P were added annually to the overlying water body in the E.H via flux from sediments. This amount is about 52% of the total input of DIP in the harbor marine environment.

In the case of nitrogen, experiments indicated that the highest flux of ammonia occurred during the first five days, after that the rate of reflux decreased gradually (Figure 1). Several workers found that nitrogen flux from sediments is mainly in the form of ammonia, and the highest rate was measured during the first 17 hours of incubation (DUGDALE *et al.*, 1977). On the other hand, the rate of nitrate flux was much smaller and irregular (figure 1). The average amount of the flux of nitrate-nitrogen and ammonia from bottom sediments amounted to 1.78 and 3.77 kg/Km2, respectively. The annual averages estimated for the E.H. area were 4.50 and 9.49 Tons, respectively. In other words, both nitrate and ammonia fluxes represented about 60% and 186% of their annual input to the harbor water. respectively (ABOUL-KASSIM, 1987).

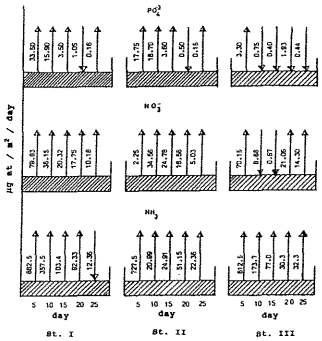

Figure 1: Flux of phosphate, nitrate and ammonia into or out the harbor sediments at stations I, II, and III (µg at/m^2/day)

The high contribution of both phosphorus and nitrogen concentrations to the overlying water column of the harbor environment via flux from sediments is a characteristic feature for the sewage-impacted coastal marine environment of Alexandria with a short flushing time (i.e. 5 months), even when compared with other heavily polluted areas in the Mediterranean region (ABOUL-KASSIM, 1987).

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Impact of sewage pollution on nutrients uptake rate by Phytoplankton in a South-Eastern Mediterranean Basin

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Phosphorus and nitrogen compounds play key roles in plant photosynthesis. Phytoplankton normally satisfy their nutrient requirements by their direct assimilation. Phosphorus and nitrogen uptakes are virtually confined to the euphotic layer of the sea, since they are a photosynthetic processes. Although all forms of nitrogen and phosphorus can be assimilated by most species of phytoplankton, nitrate, ammonia and orthophosphate are usually used preferentially (GLIBERT *et al.*, 1991; KROM *et al.*, 1991). According to GARSIDE (1981), autotrophic bacteria are also able to assimilate nitrogen. These resemble green plants in their ability to build carbohydrates and proteins. Some of these, known as photosynthetic, possess coloring material, or bacteriochlorin and use radiant energy in building up protoplasm, while others, known as chemosynthetic, derive their energy from the oxidation of various inorganic compounds.

Anthropogenic nutrients input plays an important role in the high productivity and biomass of the coastal zone of Alexandria (Egypt) relative to its continental shelf. The amount of production depends on the external supply of nutrients (allochthonous input) and the internal nutrient regeneration rate (ABOUL-KASSIM, 1987). The relationship between variable nutrient supply, the capacity for its utilization by different classes of phytoplankton, and ultimately the amount of recycling and export of nutrients from Alexandria coastal waters are not well understood. Our objective in this paper is to study carefully the nutrient uptake rates of phytoplankton (light and dark uptakes) in the sewage-impacted water of the Eastern Harbor (E.H), Alexandria.

The study area is a semi-circular shallow bay, surrounded by Alexandria city, connected to the Mediterranean through two openings. The basin is subjected annually to about $35x10^6$ m^3 of unprocessed sewage, rendering its flushing time to be 5 months. The uptake rates of orthophosphate, nitrate and ammonia by phytoplankton were determined according to EPPLY *et al.* (1969). Five liters of the harbor water were collected and divided into 5 portions, each of one liter. These portions were enriched with increasing concentrations of:

(1)- phosphorus (2.5, 5, 10, 15, 30 ug at/l) using an A.R. standard KH_2PO_4,
(2)- nitrate (2.5, 5, 10, 15, 30 ug at/l) using an A.R. standard KNO_3, and
(3)- ammonia (5, 10, 20, 30, 40 ug at/l) using NH_4SO_4.

Aliquots of 300 ml from each sample were placed in dark and light stoppered bottles and incubated *in situ* for 4 hours at about 25 cm below the surface. After incubation, the initial and final nutrients concentrations in each sample were determined and the rate of uptake rate/hour was calculated.

Results showed that the light and dark uptake rates of orthophosphate (Figure 1) increased gradually by increasing phosphorus concentrations, reaching maximum at 17.5 ug at/l after which they decreased. The annual rate of phosphorus (light) uptake by phytoplankton was calculated to be 860 kg/year.

The annual rate of ammonia and nitrate light uptake rates were found to be 83.0 and 41.5 Tons/km^2 or about 210 and 105 Tons/year, respectively. However, the greater part of these amounts is probably due to bacterial uptake (ABOUL-KASSIM, 1987). MAHMOUD (1985) gave a value of 43.4 and 30.7 Tons/Km^2 for ammonia and nitrate uptake in El-Mex Bay of Alexandria (affected by agricultural run-off, i.e. $2.57x10^6$ m^3/yr from Umom drain, ABOUL-KASSIM, 1990). This might indicate the enhancement effect of sewage disposed in the harbor basin on the uptake rates by phytoplankton. The difference of ammonia uptake in dark and light bottles is less significant than that of nitrate and phosphate (Figure 1). Likewise, a dark and light uptake was also observed in the case of nitrate. These high uptake rates are mostly due to the high bacterial biomass (measured by the adenosine tri-phosphate method) in the Eastern Harbor; i.e. average 0.46 mg C/l (ABOUL-KASSIM *et al.*, 1992). Statistically, high significant correlations occurred between both light and dark nutrients uptake rates, and the regression equations relating these variables are:

1- for orthophosphate: Light uptake = - 0.12653 + 2.2449 Dark uptake (r^2= 0.800).
2- for nitrate: Light uptake = 0.86835 + 1.1433 Dark uptake (r^2= 0.964).
3- for ammonia: Light uptake = 0.57913 + 1.0010 Dark uptake (r^2= 0.996).

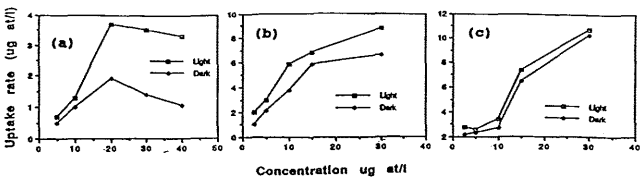

Figure 1: Uptake of a)- orthophosphate, b)- nitrate and c)- ammonia by phytoplankton at both light and dark bottles.

In conclusion, the high light and dark uptake rates of nutrients in the E.H. of Alexandria compared with other polluted areas in the Mediterranean area (ABOUL-KASSIM, 1987) is undoubtedly due to the high standing stock of phytoplankton (i.e. 5.14±2.71 mg chl a/l) and bacterial biomass (i.e. 52% of living biomass). These high living biomass is due to the continuous supply of nutrients (allochthonous source) in the harbor, i.e. 420 tons N/yr (EL-NADY *et al.*, 1990) and 1.094 tons P/l (DOWIDAR *et al.*, 1990).

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Phosphorus and ammonia release experiments in the sewage-impacted coastal marine sediments of Alexandria, Egypt.

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Introduction

Sorption and desorption of nutrient salts by the sediment particles probably account for about 20-30% of the nutrients turnover in the marine environment (MARTIN, 1970; SEITZINGER, 1987) which play important role in nutrients contribution to the overlying water column. In this paper, our target is to study, experimentally, the amount of phosphorus adsorbed on sediments as well as to measure the sediment bound ammonium-nitrogen characteristic to the marine environment of Alexandria.

Study area

The Eastern Harbour (E.H) of Alexandria is a relatively shallow semi-closed basin, sheltered from the sea by an artificial break-water, leaving two openings through which the exchange of the harbour water and the neritic Mediterranean water take place. About 35.2×10^6 m^3 of domestic sewage are discharged into the Eastern Harbour of Alexandria through 11 outfalls, distributed along the coast. This quantity is about 2.3 times the water volume of this basin.

Material and Method

Representative bottom sediment samples were collected from 3 stations in the Eastern Harbor. The sediment bound ammonium-nitrogen from each station was mechanically released by centrifugation (3600 RPM) a 1 cc wet sediment sample for ten minutes in 150 ml of ammonia free distilled water (KAMIYAMA *et al.*, 1977). The most suitable sediment to water ratio was found to be 1 cc sediment to 150 cc distilled water (MAHMOUD, 1985). The concentration of ammonia in the supernatant distilled water was measured. The liberation of ammonia-nitrogen from the sediment sample may result from the disruption of the equilibrium between the dissolved form in the interstitial water and adsorbed form on the particles by addition of the distilled water, and a new equilibrium state reached. The results were expressed as ug/lcc/l.

Phosphorus adsorbed on sediments was measured by shaking a 1 cc sediment for one hour with 150 ml of distilled water in an electric shaker. The phosphate released was measured. The results were expressed in ug at/l cc/l. As the desorption of phosphate is a function of pH, the same experiment was carried out using phosphate distilled water of different pH. The range used was 6-9, representing that of the harbor water, to yield maximum adsorption of phosphate for the harbor sediments.

Results and discussion

In the present study, the amount of phosphorus released from 1 cc sediment sample after shaking for one hour at the *in situ* pH, was obtained for different stations (Table 1). It was found that the amount of phosphorus released by shaking were higher than the corresponding *in situ* concentrations in the bottom water. This is obviously due to the strong tendancy of phosphate to be adsorbed in sediments and suspended particles. The *in situ* concentration in near bottom sea water was proportional to the concentration of phosphorus in surficial sediments. The ratio is almost constant (Table 1). This indicates that the distribution of the water column caused by winds and/or vertical mixing processes would increase the concentration of phosphorus in the overlying water column by appreciable amounts even at the same pH.

The equilibrium state between phosphorus adsorbed on the sediment particles and that dissolved in the overlying water seems to be grately governed by the oxidation (Table 1). This indicates that the distribution of the water column caused by winds and/or vertical mixing processes would increase the concentration of phosphorus in the overlying water column by appreciable amounts even at the same pH.

The equilibrium state between phosphorus absorbed on the sediment particles and that dissolved in the overlying water seems to be grately governed by the oxidation state of the bottom sediments. At pH range between 6-8, a complete absorption takes place. According to El-Sayed (1977), an increase in salinity values from 27-39‰ had no significant effect on the desorption processes.

Table 1: Amount of phosphate released by shaking (ug aVcc. sediment), *in situ* concentrations in near bottom sea water, and the ratio between *in situ* concentration and that released from sediments, as well as pH and salinity (‰) for selected stations in the harbor basin

Station	Phosphate released per liter (1)	*in situ* conc. in near shore bottom sea water (2)	Ratio [(2)/(1)]	pH	S‰
I	2.27	1.90	0.84	7.62	38.10
II	2.07	1.65	0.80	7.43	37.98
III	3.33	2.35	0.71	7.12	36.17

Experimentally, it was found that ammonia-nitrogen concentration in bottom waters (in situ) was less than that released from sediments. This negative sediment water gradient favours the release of ammonia-nitrogen to the overlying water. Also, the *in situ* concentration of ammonia near the bottom was inversely proportional to the ambient salinity (Table 2).

Table 2: Amount of ammonia released from sediments by centrifugation versus *in situ* ammonia concentrations (ug at/l) and salinity (‰) for selected stations in the harbor basin.

Station	Ammonia released (1)	*in situ* conc. in near shore bottom sea water (2)	Ratio [(2)/(1)]	pH	S‰
I	11.33	5.39	0.48	7.62	38.10
II	10.00	5.85	0.59	7.43	37.98
III	15.33	9.30	0.61	7.12	36.17

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Flux à l'Interface eau-sédiment Quantification, Réaction et Bilan

Ayed ADDED

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Les flux d'alcalinité, de TCO2, d'azote, et des phosphates calculés à partir des eaux interstitielles et mesurés *in situ* à l'aide de chambres incubatrices dans la Lagune de Ghar El Melh, figurent dans le tableau suivant:

Eléments	Flux ($mM/m^2/jour$)	
	calculés hiver - été	mesurés hiver - été
Oxygène		11,700- 14,000
Alcalinité	0,049 - 0,008	57,600- 0,000
TCO2		5,760- 1,840
Azote	0,160 - 1,230	0,000- 3,920
Phosphates	0,000 - 0,000	0,000- 0,000

A partir des données du tableau nous pouvons tirer les conclusions suivantes:

1) en hiver, l'alcalinité calculée étant supérieure à celle mesurée, indique que la dégradation de la matière organique est forte au niveau de l'interface eau-sédiment.

2) les diminutions des flux d'alcalinité et de TCO2 de l'hiver à l'été suggèrent que la dégradation aérobique de la matière organique diminue en été.

3) en été, le flux d'azote mesuré est supérieur au flux calculé.

4) le fait que les flux d'azote augmentent de l'hiver à l'été signifie que la dégradation de la matière organique passe d'un stade aérobique à un stade anaérobique (en hiver l'azote est sous forme de nitrates et en été il est sous forme d'ammoniaque).

5) l'absence totale de phosphates échangés entre le sédiment et l'eau surnageante (flux nuls) signifie que ceux-ci sont adsorbés sur le sédiment.

En supposant que les flux de TCO2 sont égaux aux taux de dégradation de la matière organique (les précipitations/dissolutions sont négligées car elles sont faibles), les bilans d'alcalinité prenant en compte les taux d'oxygène consommé ont permis de confirmer l'oxydation aérobique de la matière organique en hiver (100% de 02 consommé) et l'oxydation anaérobique en été (0% de 02 sont consommés par la matière organique et 100% de 02 ont servi pour oxyder essentiellement les sulfures solubles):

Qualité du milieu marin sur un site conchylicole méditerranéen (baie du Lazaret, rade de Toulon, France)

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La baie du Lazaret, en rade de Toulon, est le siège d'exploitations mytilicoles (en filières suspendues) et aquacoles (grossissement de loups). Le maintien de ces activités a conduit au besoin **d'évaluer le niveau de qualité du milieu marin dans la baie.** Celui-ci a été établi à partir de la surveillance des coquillages et de la recherche du degré de contamination des sédiments.

Les **concentrations en contaminants dans les moules,** mises en évidence par le RNO depuis 1979 (1) **sont élevées.**

Pour les **germes bactériens**, elles sont supérieures à 3000 Coliformes fécaux par 100 ml de chair, dans plus de 10 % des cas (au lieu de 0 % requis par les normes); ceci correspond à une qualité sanitaire de type "insalubre".

Les **concentrations en contaminants chimiques** dans les moules, comparées à des valeurs de référence (RNO, 1988) correspondent à :

. un **niveau de "contamination chronique faible"** pour le DDT (120 à 140 µg/kg), le **Zinc** (100 à 350 µg/kg), et le **Cadmium** (1,05 mg/kg; niveau "faible" des conventions d'Oslo et Paris),

. un **niveau de "contamination chronique forte"** pour les **PCB** (1065 µg/kg en moyenne, de 300 à 3700), l'une des plus élevées de la façade méditerranéenne, les **hydrocarbures** polyarômatiques totaux (9,66 mg/kg en moyenne, de 3 à 20), le **Plomb** (10 mg/kg en moyenne, de 3 à 19), l'une des plus élevées du littoral national, et le **Mercure** (0,40 mg/kg en moyenne, de 0,20 à 0,65) l'une des plus élevées du littoral méditerranéen (niveau "faible" des conventions d'Oslo et Paris).

Les investigations menées sur les sédiments (12 points d'échantillonnages et 5 carottes) montrent des **teneurs en germes bactériens trés faibles,** sans rapport avec celles rencontrées dans les moules (2). Les teneurs les plus élevées sont trouvées dans les sédiments superficiels, au centre de la baie, sous les tables à moules (au niveau des biodépôts riches en matières organiques).

Les **concentrations en contaminants chimiques dans les sédiments,** comparées aux valeurs RNO prises comme référence (1), confirment les niveaux de contamination identifiés dans les moules:

. **niveau faible, habituel pour le milieu naturel,** pour le **Mercure** (0,08 à 0,33 µg/g),

. **niveau de "contamination faible"** pour le **Plomb** (46 à 149 µg/g), le **Zinc** (93 à 264 µg/g), le **Cuivre** (23 à 117 µg/g),

. **niveau de "contamination chronique significative"** pour les **hydrocarbures** totaux (300 à 1200 mg/kg) et les **PCB** (31 à 228 ng/g).

Leur **répartition** montre d'autre part:

- une **bonne corrélation avec la fraction fine** dans le sédiment, plus représentée **au centre de la baie** (sous les tables à moules) qu'à la périphérie. Les matières en suspension et les processus hydrosédimentaires joueraient donc un rôle majeur dans la contamination de la baie,
- des concentrations diminuant depuis l'entrée jusqu'en fond de baie, ce qui suggère que **l'origine majeure des contaminants est extérieure à la baie,** et qu'ils proviennent du reste de la rade de Toulon,
- des concentrations **diminuant dans les sédiments plus profonds** (activité de bioturbation). Le **"stock de contamination" apparaît donc cantonné dans la couche de sédiments superficiels, de 10 cm d'épaisseur, atteignant 40 cm au niveau des biodépôts. Il est de ce fait maximal au centre de la baie.** Les moules exploitées semblent contribuer à cette localisation préférentielle, par le biais de la biodéposition (féces et pseudo féces).

La baie du Lazaret, bien que ne possédant pas de source propre de pollution, est le siège d'une **contamination chronique,** tant pour les polluants bactériens (sanitaires) que chimiques (Hydrocarbures, PCB et Plomb). **L'origine majeure apparaît extérieure à la rade de Toulon),** et relever d'un **double processus,** combinant la **dynamique sédimentaire** (sédimentation-remise en suspension), et la **bioconcentration** par les moules. Les sédiments jouent donc un rôle majeur en tant que réservoir et source potentielle de pollution de la baie.

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Effet d'un coup de vent d'Est sur la qualité des eaux et des moules en zone côtière en méditerranéenne (rade de Toulon, France)

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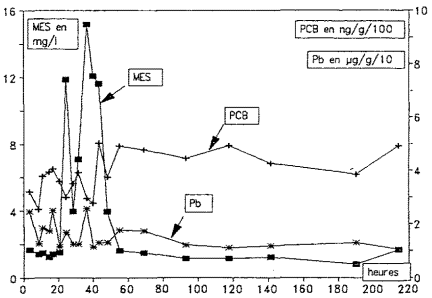
La baie du Lazaret, ouverte vers l'Est et vers la rade de Toulon, présente un niveau de contamination élevé (PCB, Hydrocarbures, Plomb), tant au niveau des moules exploitées que des sédiments (cf. communication précédente). Ces derniers constituent, en fait, à la fois un "réservoir" et la source majeure de pollution pour la baie. Pour comprendre les mécanismes de contamination de la baie, nous avons **suivi en continu la qualité des eaux et des moules lors d'une remise en suspension des sédiments induite par un coup de vent d'Est.** Une campagne en mer a été réalisée "à bord" d'une table mytilicole, pendant 8 jours (211 heures), en un point fixe, situé au centre de la baie (profondeur 5 m). Le coup de **vent d'Est a dépassé 10m/s (force 5 à 9)** de la 10 ième à la 40 ième heure, avec **deux pics** de vent maximum à la **20-25 ième heure** (19m/s) et **34-38 ième heure** (18m/s). A la 41 ième heure le vent est passé brutalement à un régime de Nord-Ouest assez fort (mistral).

On a observé:

- la **formation progressive d'une houle d'est** atteignant 1 m d'amplitude, de "**courants**" **en surface et au fond**, de directions opposées (phénomène de compensation), et **un refroidissement** rapide des masses d'eau (1,5°C).
- une **augmentation de la turbidité et de la charge particulaire dans la masse d'eau (MES), traduisant une remise en suspension des sédiments. Les MES totales augmentent de 1 à 15 mg/l** pendant le coup de vent, puis diminuent rapidement par la suite. Les particules les plus fines, les plus riches en matières organiques et les plus polluées (vases de faible densité), apparaissent dès les premières heures. Les sédiments plus grossiers à dominante minérale (sables) sont mobilisés plus tardivement, et déterminent les variations pondérales mesurées des MES (15 mg/l).
- une **augmentation des concentrations en germes bactériens dans l'eau** (de 13 à 2100 Coliformes fécaux par 100 ml), et **dans les moules** (de 166 à 10 230 CF/100 g), **au moment du pic des MES** (1). La remise en suspension des sédiments consécutive à un vent fort, entraîne donc une contamination des moules qui peut dépasser les normes sanitaires.
- une **augmentation de la contamination chimique de la masse d'eau**, qui se produit **avec des vitesses variables selon le contaminant étudié**; dès les premières heures et simultanément à la fraction fine pour le cadmium et le zinc, plus tardivement pour le cuivre, puis, simultanément au pic des MES pour les hydrocarbures et le plomb. Ceci suggère **l'existence d'affinités spécifiques entre les contaminants et les classes de particules.** Le calcul des teneurs théoriques (en prenant en compte les MES mesurées, en mg/l, et les teneurs en polluants dans le sédiment superficiel), aboutissent à des valeurs du même ordre de grandeur que celles qui ont été mesurées dans la masse d'eau; ce qui confirme que l'arrivée des contaminants dans la masse d'eau est bien liée à la remise en suspension des sédiments.

Les **concentrations en contaminants chimiques augmentent globalement dans les moules,** mais présentent plusieurs types de comportements (cf figure).

Les **métaux** présentent de grandes variations pendant le coup de vent. **Le plomb et le Cuivre** suivent les MES pendant le coup de vent, puis retournent à un niveau de base. Leur expulsion des moules est immédiate, et il n'apparaît pas de bioaccumulation.



Les **hydrocarbures (HAP) et les PCB** apparaissent plus lentement, un à deux jours aprés le coup de vent. Ils se maintiennent à un niveau plus élevé qu'avant le coup de vent. Cette persistance suggère une bioaccumulation assez rapide de ces substances liposolubles. Cette observation est d'ailleurs en accord avec les expériences de RIBERA (2), qui a mis en évidence chez les moules exposées aux HAP, une induction très rapide d'une activité enzymatique détoxifiante B(a)PMo (Benzo(a)Pyrène Mono-oxygènase).

Le **Mercure** présente une situation intermédiaire. On pourrait l'attribuer à sa distribution en deux formes, l'une minérale, dont le comportement est identique à celui des autres métaux, l'autre organique (méthylmercure), liposoluble, et donc plus rapidement assimilable.

On remarque enfin, que **le vent d'Ouest** assez fort qui a suivi, **n'engendre pas de processus de même nature.** Dans ce cas, il pourrait exister une sortie d'eaux de surface, hors de la baie (vers l'Est), compensée par des eaux profondes venant de la rade de Toulon, susceptibles d'apporter des contaminants.

Ces observations montrent l'**importance des phénomènes météorologiques, sur la qualité des eaux et des moules, par le biais de la remise en suspension des sédiments. Les processus mis en jeu aboutissent finalement à un transfert des contaminants piégés dans les sédiments, vers l'eau et les moules, conduisant (malgré la brièveté des phénomènes), à la bioaccumulation de certains d'entre eux (PCB, Hydrocarbures).**

De tels phénomènes (à caractère aléatoire), ont une grande importance en zone côtière, particulièrement en Méditerranée, du fait des conditions spécifiques (dynamique météohydro-sédimentaire), et de leurs fréquences. On sait en effet qu'en baie du Lazaret, les vents d'Est soufflent 30% du temps, et sont forts en hiver (janvier-mars), et en automne.

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C

A proposed spectrofluorometric method for measuring Polycyclic Aromatic Hydrocarbons without interference

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Because of simplicity as well as sensitivity of the UV-spectrofluorometry, it is commonly used with great success in the detection and determination of petrogenic polyaromatic hydrocarbons (PAH), (AWAD, 1989; HEROS, 1972; GREFFARD and MEURY, 1967). These compounds are of great value in properly the human environment, especially since many of them are proved to be carcinogen. From methodological point of view, although the usage of UV-spectrofluorometry is fairly sensitive, its specificity for the determination of any narticular PAH compound in a mixture is poor (SAWICKI *et al.*, 1960). In fact, the method is based sirnply on the fact that any PAH in a mixture has sharp characteristic absorption peaks which (in the case of prominent peaks) usually protrude above the background absorption of the mixture. The estimation of concentration of a Particular PAH in the mixture is usually accomplished by comparison of the intensity of the prominent fluorescence peak produced by the application of an excitation at certain wave length with that produced from a reference solution containing known amount of the measured compound. This is usually followed without considering the presence of other PAH compounds in the mixture having fluorescence bands close to that of the compound being analyzed which interfers with the accuracy of the technique.

The present article shows to what extent the presence of two polyaromatic hydrocarbons compounds (benzo-8,9-fluoranthene (BKF) and perylene (P)) is affecting the accuracy of UV-spectrofluorometry in the detection of the most potent carcinogen compound benzo-3,4-pyrene (BaP) (SONTAGE, 1981; HEROS, 1972). However, an analytical method depending on the complete activation and fluorescence spectral analysis is proposed. By following this method, detection and estimation of specific compound without interference of others could be successfully carried out.

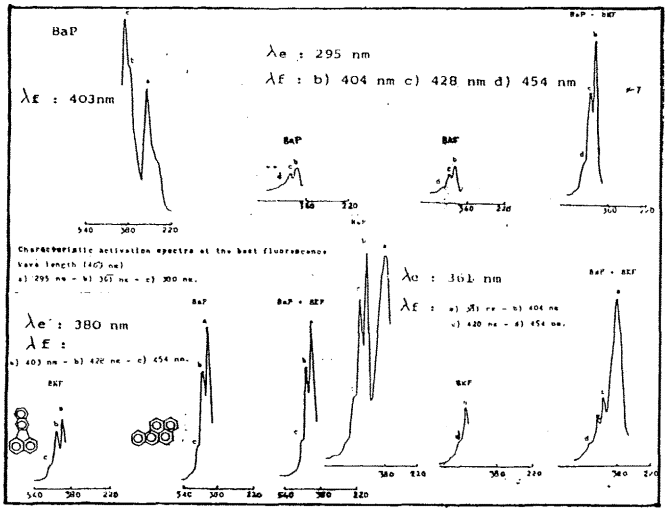
Practically, two experiments have been established. The first is devoted for examining the interference effect of the presence of BKF on the measurement of BaP using n-pentane as solvent, while the second for the detection and measurement of both BaP and perylene in mixture without interference of their measured fluorescence spectra usinq sulfuric acid as solvent.

The used instrument for the determination of activation and fluorescence spectra is Baird fluoripoint spectrofluorometer, Ratiometric RC 200.

The proposed method is simply based on complete analysis of BaP activation spectra in order to select one of them (even if it is not the best one producing the most intense fluorescence band) at which certain PAH compound could be determined without interference of other chemicals in a mixture.

For the determination of BaP in n-pentane solution containing BKF, it was found that BaP could be estimated at 381 nm fluorescence wave length through activation at 295 nm without interference of BKF. Throuqhout the same methodology, BaP could be determined without interference of perylene by applying a 283 nm activation wave length for their solutions in sulfuric acid. However, the two compounds could be detected separately at fluorescence bands corresponding to 385 and 396 nm respectively. The figure below inclucle.

The figure below inclucles an example for the followed methodology in the case of detection of BaP and BKF without interference when they are present together.



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Dissolved/dispersed petroleum hydrocarbons in Eastern Aegean Sea

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The purpose of this study was to establish the background of petroleum hydrocarbons dispersed and dissolved in the surface waters of the Eastern Aegean Sea and Turkish shoreline. The average dissolved and dispersed petroleum hydrocarbons concentrations for the limited numbers of surface waters samples from the Aegean Sea were reported as 0.67 µg/l by SAKARYA (1985). Samples were collected during 1986-1989 for four seasons in the Aegean Sea. IOC/UNEP (1984) manual for monitoring oil and dissolved/dispersed petroleum hydrocarbons in marine waters was used for sampling, extraction and the overall analytical procedure.

Samples were taken at depth of 1 m using a sampler and kept in a dark and cool place on board of the ship, until delivered to the shore laboratory for analysis. The Sea water samples was extracted twice in a separatory funnel with 2x25 ml CCl_4. The combined extracts were dried with the addition of anhydrous Na_2SO_4 in rotary evaporator. Care was taken to remove all of the carbon tetrachloride (CCl_4) which quenches fluorescense. The residue was dissolved in 5 ml of aromatic free n-hexane and fluorescense measured on a Turner, Model 430 Fluorescense Spectrometer, with 1 cm quartz cell. The intensity of fluorescense was measured at 360 nm (excitation at 310 nm). Chrysene was chosen as an intercomparison chemical for intercalibration of the procedure. The working standards were in the same range as the sea water samples. Blanks and chrysene standards were prepared using the same procedure as that for the samples.

Study area and positions of the sampling stations are given in Fig.1. The coastal and open surface waters showed a concentration range of 0.09 - 25.5 µg/l but most of the results are within 0.09-1.92 µg/l range only a few samples had above 10 µg/l values. Frequancy disribution of petroleum hydrocarbons concentrations in samples is given in Fig.2. It was observed during these cruises that the relatively large quantities of dissolved oils were found at the Aegean entrance region of Dardanelles in the northern Aegean Sea. In this area, debalasting, release of wash waters and bilges from tankers and other ships were permitted in the past and has probably still been practiced by many boats today. Dardanelles strait is one of the main navigation route for the Black Sea.

The levels of dissolved dispersed petroleum hydrocarbons at near Aliaga Bay which encloses a large refinary and petrochemicals complex, are relatively high and fluctuate widely. Deliberate oil spill from ships and tankers in addition to the wastes coming from the oil refinery can be considered as the possible cause of the high oil concentrations in the waters of Aliaga Bay.

Therefore, the Aegean waters may be considered unpolluted by dissolved and dispersed petroleum hydrocarbons when compared with the other seas of the world. The petroleum hydrocarbons concentration levels of all obtained results from the investigated area can be considered in the safely limit with respect to National Academy Report (1975).

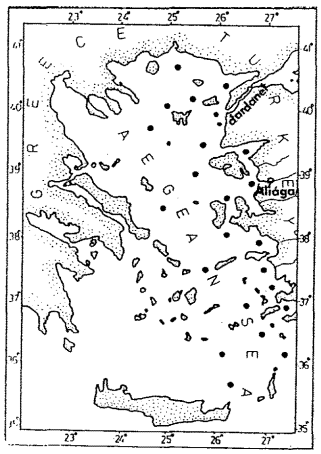

Fig:1 Sampling stations

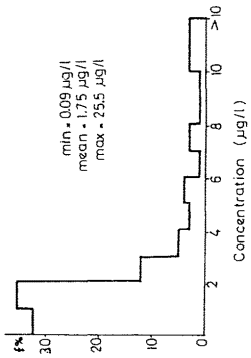

Fig:2 Frequency distribution of DDPH

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Gas exchange at the air - sea interface in the Mediterranean Area

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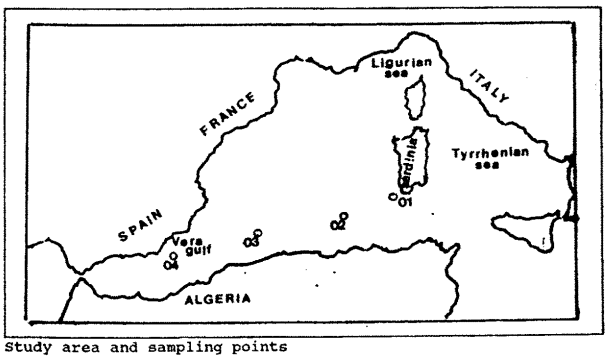
[b] ENEA-CRAM, La SPEZIA (**Italy**)
[c] ENEL-CRTN, MILANO (**Italy**)

To elucidate the mechanisms governing the air-sea fluxes of CO_2 under different meteoclimatic conditions ENEA (Ente Nazionale per le Nuove Tecnologie, l'Energia e l'Ambiente), ENEL (Ente Nazionale per l'Energia Elettrica) and CISE (Centro Informazioni Studi Esperienze) have carried out an experimental study in the Western Mediterranean sea.

The study is to be considered as preliminary to a large study that ENEA, ENEL and CISE will carry out in the frame of the CEC MAST II Program, Mediterranean targeted project. The experimental activity was carried out on July-August 1991 during the cruise of the oceanographic R/V *Bannock* of the Italian National Research Council. The studied area was localized along the way between Sardinia Island (Italy) and Vera Gulf (Spain) (Fig,1).



Study area and sampling points

Gas exchange process was investigated by the radon deficiency method and by direct evaluation of the net CO_2 flux across the air-sea interface. The driving force for CO_2 gas transfer has been characterized in terms of the difference between the CO_2 partial pressure in the surface sea water and in the overlying atmosphere (ΔpCO_2) (TAKAHASHI *et al.*, 1983).

CO_2 was determined by gascromatography after sampling in air at 10 m above the sea surface. Inorganic carbon species were determined in water by pH and total alkalinity measurements (GRAN, 1952). In addition dissolved CO_2 in sea water was determined by gascromatography after gas purging from water by means of CO_2-free air.

The gas exchange coefficients, expressed in terms of the piston velocity, estimated on the basis of the radon deficiency method were evaluated (BROECKER and PENG, 1974). The method and results of the piston velocity calculations based on the vertical distribution of ^{222}Rn in the mixed layer are reported in another separated paper presented at this Congress (BONIFORTI *et al.*).

Meteorological parameters (air and water temperature, pressure, humidity, wind speed and direction etc.) sea water parameters (total alkalinity, pH, free dissolved CO_2) and air CO_2 concentrations were measured in order to provide data sets useful in developing and evaluating gas transfer models.

Moreover, a total number of 12 water samples were collected from the investigated area and analized for ^{14}C. Radiocarbon analysis was performed by benzene syntesis method (TAMERS, 1975) and very low background liquid scintillation counting (LKB Wallac Qantulus 1220).The obtain data will be useful to estimate water masses mixing in the Western Mediterranean sea.

Field activity permitted to experiment on board large volume (200 l) water samplers and to evaluate CO_2 extraction efficiency from such large devices.

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Transformed ferroalloy waste products as possible scavengers in the Krka River Estuary (Eastern Adriactic Coast, Croatia)

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In the recent paper describing processes affecting the fate of mercury in the Krka River Estuary (BILINSKI *et al.*, 1992) we have identified some of the minerals at the freshwater-seawater interface (FSI). The sampling station was under the waterfalls (Skradinski Buk). The identified solid phases were calcite, quartz, calcium silicate hydrate and takanelite. It was assumed that some of these particles are connected with industrial wastes from the ferroalloy factory situated in the vicinity of the city of Sibenik, 30 km downstream from the sampling station.

αMn and αFe are produced in the factory from the ore braunite. Slags identified with calcium manganate and with bustamite are deposited in the vicinity of the factory. Industrial dust is released in the air in large quantity.

In the present work, transformations of these waste products were studied in the Krka River estuarine waters of different salinities. The greatest part of the waste is rather water soluble. In addition to natural minerals, different minerals were obtained by the dissolution and reprecipitation process, some of which were identified earlier in the Krka River Estuary and can act as scavengers for many trace metals.

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C

Accumulation of Mercury species by Mussels *Mytilus galloprovincialis* in estuarine and marine environment

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Research study concerning the mercury cycle in the Krka River Estuary demonstrated that his area is in the greatest part unpolluted with respect to mercury. Mercury distribution in the native mussel populations showed that they are significantly affected by the internal biological factors, which results in different spatial mercury pattern in mussels from that one observed in sediments and water.

The aim of this work was to study the accumulation of mercury species under better biologicaly controlled conditions, which can be provided using transplanted mussels of a known age with more uniform biometric characteristics than the native ones (1).

A culture of one-year old mussels *Mytilus galloprovincialis*, Lmk. were transplanted to four locations in the Krka River Estuary and nearby coastal area (Eastern Adriatic coast). Biometric parameters of mussels and total and methyl mercury concentration in soft tissues were analyzed four times during 1988/89 (270 days). Both total and methyl mercury concentrations were significantly correlated with shell weight, wet weight and dry weight of mussels. Mercury concentrations were generally decreasing with a dry weight of mussels, but a pronounced accumulation of organic form over the total mercury can be recognized from the slopes of the regression lines. The amount of methyl mercury accumulated per liter of water by an average mussel was twice higher than for the total mercury, and from such calculations the methyl mercury concentrations in water of the Krka River Estuary was estimated.

From this experiment it can be proved that even transplanted mussels can not be used as bioindicators for low mercury concentration level in water.

Further investigations lead to:

(i) the exchange of mercury speciation by biotransportation, and

(ii) the determination of limits of required difference in the mercury-water concentration level for the applicability of transplanted mussels as indicator organisms for mercury monitoring.

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Trophic conditions of waters in the Gulf of La Spezia (Ligurian Sea)

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Introduction

The Gulf of La Spezia (Ligurian Sea) is divided by a breakerwater into an inner zone (harbour) and an external zone. The harbour is subjected to pollution from various sources, the most important of which are of civil origin. In order to estimate the trophic conditions of waters in the Gulf, surface and bottom water samples were collected monthly in the period December 1989 - June 1991 to analyse chlorophyll a and nutrient concentrations. The following nutrients were determined: N-NH3, N-N02, N-N03, P-P04, total P, organic P and Si; just before sampling, the main physico-chemical parameters (pH, temperature, salinity and dissolved oxygen) were recorded.

Methods

Sample collection was carried out in three stations (Fig. 1): station 1, near a sewage pollution source (Lagora channel outfall); station 2, within the harbour, but far from pollution sources; station 3, outside the harbour.

Nutrients were determined by an AutoAnalyze Technicon II utilizing standard methodologies (Methods of Seawater Analysis, 1983). Chlorophyll a was measured by the method SCOR-UNESCO (1964). Physico-chemical parameters were recorded *in situ* by an Idronaut Ocean Seven Probe (Milan).

Results and discussion

As expected, the three stations show different situations (Tab. 1). Trophic parameters exhibit higher values at the station 1, which is located near the pollution sources, and reveal a relationship with rain events. This can explain why chlorophyll peaks related to atmospheric events occur in addition to expected peaks in spring and autumn. In fact salinity is inversely correlated to ammonia ($p<0.05$) nitrates ($p<0.02$) and silicates ($p<0.01$) and to chlorophyll too ($p<0.01$), which is, in turn, positively correlated to the same nutrients ($p<0.02$ for ammonia, $p<0.01$ for nitrates and $p<0.001$ for silicates). This means that primary production is stimulated by the inputs of nutrients from Lagora channel which are enhanced by run-off after rain events. The lack of correlation between chlorophyll and phosphate might mean that phosphate is the limiting nutrient; this can also be supported by the fact that sometimes chlorophyll and phosphate maxima are out of phase. The strong correlation between ammonia, nitrates, phosphate and silicates indicates the same source.

Station 3, outside the harbour, shows peaks of nutrients lower than station 1, and in this case silicates and nitrates are negatively and strongly ($p<0.001$) correlated to salinity. A similar, but weak relationship ($p<0.05$) can be observed between salinity and phosphate, whereas there is no correlation with ammonia. These data can be explained by the influence of river Magra waters which directly affect station 3 outside the breakerwater. In fact, silicates and nitrates are typical of riverine waters, while ammonia is typical of sewerage. Chlorophyll shows a lower number of peaks which are, in addition, less intense than in station 1 and is very weakly related ($p<0.1$) only to nitrates.

Station 2, inside the harbour and far from pollution sources, is only partly affected by continental inputs (negative correlation of salinity versus silicates and nitrates with $p<0.01$), in particular by Lagora channel, as it can be inferred by a strong correlation between ammonia, silicates, nitrates and phosphate.

As a preliminary conclusion, it can be said that the harbour environmental conditions do not appear severely impaired from a trophic point of view. This can be supported by the moderate difference in nutrient concentrations between stations 1 and 3 and by comparison with other similar environments (FRILIGOS, 1976; FABIANO *et al.*, 1978; SEIKI *et al.*, 1991). The relatively good trophic conditions of waters in the La Spezia harbour can be attributed to local hydrodynamism. BORELLA *et al.* (1992) have demonstrated an exchange between water inside and outside the harbour driven by a combined pumping effect of tide and a seiche.

Bottom water samples show the same trend, but less variability in comparison to surface samples. The effect of regeneration by sediments have to be analyzed.

Fig. 1. Sampling stations in the Gulf of La Spezia

Tab. 1. Some results of measurements in waters of the La Spezia Gulf (nutrients as µg-at/l, chlorophyll a as µg/l)

station	1	2	3
P-P04	0.26 (0.03- 1.14)	0.09 (0.01- 0.39)	0.07 (0.01- 0.15)
" b	0.11 (0.03- 0.34)	0.10 (0.02- 0.42)	0.07 (nd - 0.24)
N-NH3	3.32 (nd -13.98)	1.07 (nd - 3.43)	0.69 (nd - 2.89)
" b	1.23 (nd - 3.54)	0.96 (nd - 3.01)	0.62 (nd - 1.76)
N-N03	3.18 (0.10-17.17)	1.88 (0.06- 7.95)	1.86 (0.11- 6.80)
" b	1.29 (0.12- 4.01)	1.11 (0.04- 3.38)	0.87 (0.04- 3.36)
Si	5.10 (1.13-15.64)	2.80 (0.63- 8.77)	2.91 (0.50-12.37)
" b	3.06 (0.67- 5.88)	3.43 (0.46- 7.51)	2.03 (0.63- 4.64)
Chl. a	5.85 (0.65-15.36)	2.96 (0.10-12.87)	1.56 (0.08- 4.11)
" b	3.19 (0.27- 7.06)	2.05 (0.25- 7.88)	1.24 (0.06- 4.05)
Sal. ‰	35.86 (30.91-37.95)	36.70 (33.53-37.82)	36.69 (31.62-37.99)
" b	37.58 (36.70-37.99)	37.68 (36.91-38.06)	37.70 (37.04-38.12)

b = bottom water sample nd = not detected

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Distribution du carbone organique dissous et particulaire en Méditerranée Nord-Occidentale

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Les concentrations en carbone organique dissous et particulaire ont été mesurées au cours de plusieurs campagnes en Méditerranée Nord-Occidentale. Au plan des variations saisonnières, on note un accroissement sensible des teneurs en carbone particulaire dans la couche euphotique, pendant les campagnes de printemps et d'été. Cependant de fortes productions apparaissent également lors de blooms hivernaux (Janvier 1989). De façon plus générale, les valeurs sont plus élevées dans la zone euphotique, en liaison avec la production primaire et en zone côtière du fait d'une turbidité accrue. Dans ce cas, les pourcentages de carbone organique dans la suspension sont alors moins élevés.

Le carbone organique dissous a également été analysé à différents niveaux. Au cours des campagnes les plus récentes, une nouvelle méthode (HTCO) comparable à celle utilisée par SUGIMURA et SUZUKI (1988) a été utilisée, donnant des valeurs sensiblement plus élevées (20 à 30%). Plusieurs types de profils apparaissent, selon que l'on se situe sur le plateau continental, sur les marges ou en eau profonde. De plus fortes valeurs sont mesurées en surface au large, alors qu'en zone côtière on observe des maxima à 20-40m, coïncidant avec les maxima de fluorescence ou de chlorophylle. On peut ainsi mettre en évidence les relations existant entre le niveau de la production primaire et la concentration en carbone organique dissous. A proximité du fond, on observe également des accroissements lorsqu'il existe un néphéloïde benthique développé. Une relation linéaire directe existe dans les eaux de surface entre les concentrations de carbone dissous et particulaire. Cette relation semble dépendre de la présence de plancton, mais on note également une distribution du carbone organique dissous en surface qui montre l'influence des apports rhodaniens.

En conclusion, les concentrations en carbone organique particulaire et dissous varient relativement peu au cours des saisons et restent à des niveaux modestes dans une mer oligotrophe. Cependant, on peut mettre en évidence l'influence de la physiographie et des variations locales saisonnières de productivité, mais aussi celle du Rhône qui peut s'étendre très loin au large. Une réévaluation des stocks de carbone dissous basée sur la nouvelle méthode ne modifie pas fondamentalement les chiffres antérieurs pour l'ensemble du bassin mais peut apporter une vue nouvelle en ce qui concerne les zones côtières peu profondes.

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Niveau des principaux paramètres hydrochimiques dans les eaux peu profondes du Littoral Roumain

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Les deux dernières décennies représentèrent une période de puissants renforcements de la pression de l'activité humaine sur le milieu côtier. La croissance des influences anthropogènes, tant par l'apport fluvial que par les déversements locaux d'eaux usées industrielles ou domestiques, a eu comme résultat un fort processus d'eutrophisation à effets écologiques négatifs (floraisons planctoniques, hypoxie, mortalités benthiques). L'agressivité de ceux-ci sur le milieu marin est bien reçue par certains facteurs abiotiques du milieu, qui, par les valeurs atteintes, bien supérieures à la normalité, représentent des indicateurs hydrochimiques des eaux eutrophisées.

Le présent travail est fondé sur les observations mensuelles de la période mai - octobre 1991 sur les paramètres chimiques suivants: salinité, oxygène dissous, nitrates, nitrites, ammoniaque, phosphates, phosphore organique, urée. Les échantillons furent prélevés à la surface de l'eau dans un réseau de 14 profils couvrant la zone Sulina-Vama Veche, à partir de la côte et devant les isobathes de 5, 10 et 20 m. Les analyses chimiques ont suivi les méthodes de GRASSHOFF *et al.*, (1983).

Les limites de variation et les valeurs moyennes des trois secteurs du littoral roumain - nord (A), centre (B) et sud (C) sont présentées dans le tableau 1.

Les principales particularités sont:

- de très larges spectres de valeurs, avec des variations spectaculaires d'un mois à l'autre, selon l'instabilité des facteurs hydrologiques et hydrobiologiques. Les dimensions sont au-delà de la normalité, avec des perturbations des cycles annuels;
- l'oxygène dissous n'est plus sous le contrôle du régime thermique pendant la saison chaude de l'année, c'est le processus biologique qui devient déterminant;
- les valeurs maximales de la saturabilité et de la consommation biochimique de l'oxygène sont extrêmement élevées au centre et au sud du littoral, indiquant une intense activité biologique;
- des cas fréquents d'hypoxie au sud et au centre de la zone, souvent au-dessous des limites létales;
- un stock accru de nutrients durant toute la saison chaude où leur consommation est intense, excédent entretenu principalement par l'apport permanent du Danube;
- la dominance du phosphore minéral au nord du littoral, et de la forme organique au centre et au sud de celui-ci;
- les nitrates constituent la forme dominante de l'azote minéral au nord, et l'ammoniaque au centre et au sud du littoral;
- des quantités importantes d'azote uréique, avec des maxima toujours au centre et au sud du littoral.

Tableau 1 - Valeurs caractéristiques*

	A			B			C		
	Min.	Max.	Moyenne	Min.	Max.	Moyenne	Min.	Max.	Moyenne
DO	5,33	9,72	7,23	0,81	17,91	7,30	2,41	15,32	8,50
DO %	83,0	162,8	113,3	14,4	320,4	125,5	43,9	288,3	149,3
BOD	1,04	4,36	2,87	0,65	17,66	5,30	0,80	15,78	5,43
S ‰	0,51	8,44	3,70	7,21	17,58	12,66	4,59	17,65	12,79
SiO_4-Si	18,26	55,18	37,24	0,82	52,69	8,08	8,90	95,83	6,69
PO_4-P	3,05	4,81	3,91	0,15	18,53	1,95	0,02	22,88	1,12
P org.	0,43	1,40	0,88	0,14	16,28	2,55	0,11	10,37	2,17
NO_3-N	0,98	104,17	21,10	3,43	31,76	4,98	3,29	49,94	3,45
NO_2-N	0,35	3,43	2,25	0,19	19,43	1,29	0,16	37,38	1,14
NH_4-N	8,09	17,66	12,73	0,66	86,82	10,63	0,95	158,03	10,31
N-urée	0,7	10,71	4,49	0	21,64	5,30	0,38	30,86	4,67

*DO,BOD - cm^3/l; SiO_4-Si, FO_4-P, P org., NO_3-N, NO_2-N, NH4-N et N-urée - µmol/l)

L'analyse des données présentées indique qu'au centre et au sud du littoral roumain, où l'on ressent l'effet cumulé de l'apport fluvial du coin nord-ouest du bassin et des déversements locaux d'eaux résiduaires, les eaux côtières se caractérisent par une variabilité spatio-temporelle accrue des paramètres chimiques. Dans ces secteurs très eutrophisés, caractérisés par une intense activité biologique, les valeurs atteintes pendant la saison estivale sont maximales, dépassant fréquemment les normes techniques de qualité des eaux de surface.

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C

Surface active substances in the Adriatic Sea

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The complex mixture of organic matter in the sea comprises of different types of substances such as polysaccharides, proteins, peptides, lipids and humic substances. Most of these compounds (about 70 % of total organic carbon) are surface active, i.e. show a tendency to be concentrated by adsorption processes at the natural phase boundaries of water with the atmosphere, and with solid particles such as sediment, and biota.

In seventies new electrochemical methods were developed for research and monitoring of organic substances with surface active properties in the sea (ZVONARIC *et al.*, 1973; COSOVIC *et al.*, 1977; COSOVIC and VOJVODIC, 1982). The methods are based on measurement of adsorption phenomena at the electrode surface at conveniently selected conditions of potential, time of adsorption and transport mode. This enables a simple, rapid and direct determination of organic surface active substances in marine samples without any pretreatment of the samples. The methods have been widely used in the Adriatic Sea with the aim of determining natural levels of surface active substances, their seasonal variations, horizontal and vertical distributions, and pollutions influences (including also effects of intensive phytoplankton blooms in the North Adriatic Sea).

C

Special attention was paid to the determination and characterization of the hydrophobic fraction of organic surface active substances. It was found that enrichment of hydrophobic substances at natural phase boundaries is several times higher than for the total dissolved organic matter, thus influencing the mechanisms and rates of processes that occur at natural surfaces (COSOVIC and VOJVODIC, 1989).

Recently attempts are made to compare the surfactant activity values of the seawater samples in the North Adriatic Sea with the corresponding DOC values, which are determined by using a high-temperature catalytic oxidation (HTCO) technique, proposed by SUZUKI and SUGIMURA (SUGIMURA and SUZUKI, 1988).

We expect that reliable information may be obtained which will contribute to the knowledge of chemical composition and reactivity of organic substances in marine and estuaries systems.

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Statistical prediction for mixed uranyl complex formation in artificial seawater

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In a complexed electrolyte solution such as seawater the mixed complexes of uranyl can dominate over simple complexes in respect to the medium containing different types of ligands. One of the possible solution of this problem is based on theoretical modeling constants of mixed complexes.

DYRSSEN *et al.* (1968) model predicts the magnitude of mixed-ligand formation constants, $\beta_{a,b}$, from single-ligand type formation constants, β_N. Since seawater contains a variety of potent ligands, and mixed-ligand complexes are statistically favored relative to single-ligand type complexes, recent attempts to model trace-metal complexation in seawater have included calculations of stability constants of the following type:

$$\beta_{a,b}=\frac{(MX_aY_b)}{(M)(X)^a(Y)^b} = \frac{N!}{a!b!}\,({}_x\beta_N{}^a{}_*{}_y\beta_N{}^b)^{1/N}$$

where:

$$N=a+b; \qquad {}_x\beta_N = \frac{(MX_N)}{(M)\,(Y)^N} \qquad {}_y\beta_N = \frac{(MY_N)}{(M)\,(Y)^N}$$

On the basis of this calculations the stability constants of the mixed uranyl-hydroxo-peroxo-carbonato species has been evaluated.

Including those equilibria and their corresponding stability constants into the developed model of seawater species distributions (DJOGIC *et al.*, 1986) the pH dependance of uranyl-species has been obtained.

The calculations show that a significant percentage (20 to 30%) of uranyl species should be in the form of a uranyl mixed complexes of ligands, such as -OH, $-CO_3$, especially in the pH range 6 to 8.

The calculations performed for the photic zones where the hydrogen peroxide is present as a potential ligand (DJOGIC and BRANICA, 1991), indicate the presence of the uranyl complexes with peroxide, as well.

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Eutrophication assessment based on scaling nutrient and chl*a* values

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Ecological investigations of water pollution based on numerical classification (BOELSCH, 1977) have been used extensively for environmental planning and decision making (UN., 1984). This type of ecological application assumes discrete states in environmental quality since high resolution is required to distinguish between different pollution levels. Eutrophication assessment problems are further complicated due to seasonal trends (PAGOU & IGNATIADES, 1988). In the present work numerical classification was applied to assess eutrophication. Nutrient and chl*a* data were scaled (ordinal and binary scaling) to improve the resolution of the method.

Two sampling sites were selected along the coastal area of Mytilini, the site M1 being near the sewage outfall (eutrophic system) and the site M2 being offshore (oligotrophic system). Methodological details have been described elsewhere (PAGOU & IGNATIADES, 1988). The raw data (nutrient and chl*a* values) were used for the data analysis. The data were log transformed and mean values per station and depth were calculated. The 5 x 8 matrix (5 variables x 8 sampling sites) was row standardized. Three types of scales were developed: (a) Metric scale which was the 5 x 8 data matrix, (b) Binary scale: values exceeding the mean were expressed by the state 1 otherwise state 0, (c) Ordinal scale: Four values (1-4) were given to the data; the value 1 reflecting the most favorable condition and value 4 the least desirable situation ($1 < \mu-\sigma$; $\mu-\sigma < 2 < \mu$; $\mu < 3$ $\mu+\sigma$; $> \mu+\sigma$). The euclidean distance (ED) was used as a dissimilarity measure and the group average as a clustering algorithm (BOELSCH, 1977).

The dendrogram based on metric scaling is shown in Fig. 1(a). It is observed that the pattern is mixed since samples from M1 are grouped together with the site M2. Grouping of sampling sites M1 and M2 based on binary scaling has also shown a mixed pattern. On the contrary, the ordinal scaling (Fig. 1(c)) showed a very good resolution between M1 and M2, the two clusters fused at a similarity level about 75%.

These results indicate that ordinal scaling is the best approach in assessing eutrophication levels; this scaling might be a trade off between the high "noise" of the metric data and the oversimplified system description given by the binary scale.

Acknowledgement

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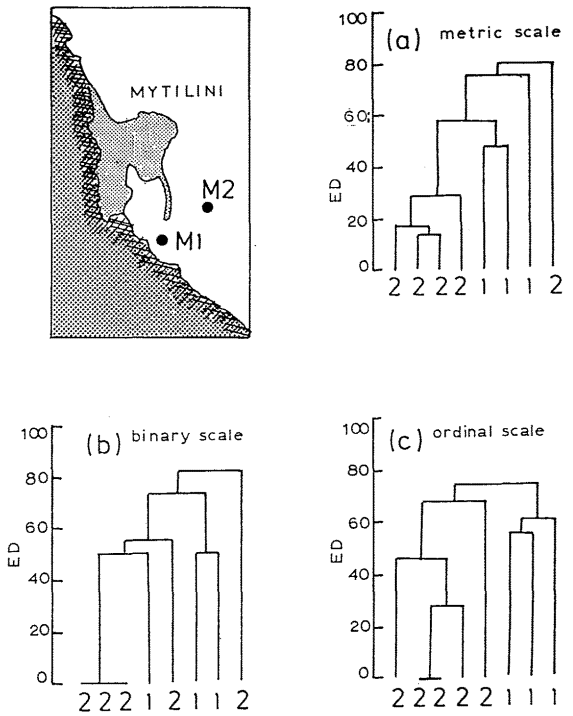

Figure 1. Top left; Station Locations (a),(b) and (c): Station grouping based on scaled data (a) metric scale (log transformed), (b) binary scaling and (c) ordinal scaling.

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Stoichmetry of some basic organic constituents in surface sediments of the Southeast Mediterranean Sea

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The Eastern harbour of Alexandria is a more or less polluted basin because of its ecological condition. To asses the degree of pollution in this area, organic constituents as organic phosphorus, nitrogen and organic carbon were measured in the surficial bottom sediments as well as the grain size analysis. A remarkable increase in these concentrations were recorded comparing with those obtained before, because of the continuous discharge of organically sewage pollution which are not biodegradable. Higher concentrations were observed at stations directly affected by sewage discharge. The comparatively low organic content in the harbour irrespective of the discharge of large amounts of untreated sewage discharge is mostly due to the effective exchange between Mediterranean neritic waters and the harbour water.

Introduction

The Eastern Harbour of Alexandria receives two types of direct anthropogenic inputs, one is domestic waste effluent; intermitting discharged to the harbour through eleven outfalls. The other from the shipyard activities at the harbour's western side. The effect of these on the hydrochemistry, nutrients and heavy metals were studied by EL-NADY (1982). Over 183 x 10^6 m^3 of untreated sewage and waste waters are discharged annually into the coastal water of Alexandria. Out of this amount, about 35.2x10^6 m^3 are discharged into the harbour. This quantity is about 2.31 times the water volume of this basin.

Material and Methods

The surface sediments from the harbour were collected using a modified Ekman grab from the sampling sits (Fig. 1). Samples were preserved frozen in an aluminium foil for further analysis of organic constituents. Portion of each sample was used for the determination of the grain size. Inorganic, organic and total phosphorus were determined according to the methods described by ASPILA *et al.* (1976). Organic nitrogen was determined by the Methods described by STRICKLAND and PARSONS (1972). The method used for the determination of dissolved and particulate organic carbon was that of MENZEL and VACCARO (1964) and its modification by FREDERICKS and SACKETT (1970).

Results and Discussion

Grain size analyses showed that sand fraction represents the main core of the sediments, that ranged from 50 to 97% with an average of 80%. The mud fraction hardly exceed few percent (< 17%) and was entirely restricted to the sheltered area. The coarser sediments were eventually concentrated in the area faces the open sea action. The gravel fraction in the deep sediments ranged between 17 and 46%.

Phosphorus content of muds is of considerable importance in estuarine and shallow water ecology. The overall average of inorganic, organic and total phosphorus of the surficial bottom sediments were 0.086±0.052%'0.02±0.011% and 0.106±0.06% respectively. These values are greater than those recorded in the oceanic and near shore sediments, but comparable to that found in polluted areas. The equilibrium state between phosphate adsorbed on the sediment particles and that dissolved in the overlaying water seems to be greatly governed by the oxidation state of the bottom sediments. At pH range between 6 and 8, a complete adsorption takes place (JITTS, 1959).

Organic nitrogen content ranged from 0.152 to 0.4% at stations III and VII respectively. The isopleths of the areal distribution of organic nitrogen showed a decrease from the eastern and western sides of the harbour.

Despite the high load of organic matter discharged into the harbour and its high fertility, the concentration of organic nitrogen was not too high (average 0.254 ± 0.1%) although higher than that in the coastal waters off the Nile Delta. This may indicate that the greater part of nitrogen in the particulate organic matter is rapidly decomposed by bacterial action and converted into soluble forms. The average weight ratio of organic nitrogen to total phosphorus (N/P) amounted to 2.68 which is resulting from the continuous discharge of nitrogenous compounds through sewage runoff.

Organic carbon content (OC) ranged from 1.73% to 9.11% at stations III (at El Boughaz opening) and VII respectively. The isopleths of organic carbon of the sediments showed a decrease from the south western sides of the harbour towards the center. The percent of OC was remarkably high (average 3.2 + 2.638%). Comparing with the Egyptian areas, the percent of organic matter in the sediments was remarkably high, presumably because of the increased productivity of the basin.

The carbon nitrogen and carbon phosphorus ratios are useful means for interpreting the data on organic carbon. The C:N ratio ranged between 6.56 and 21.44. The C/P ratio ranged between 91.0 and 285. The studied area Scores higher C/P ratios compared with the other areas.

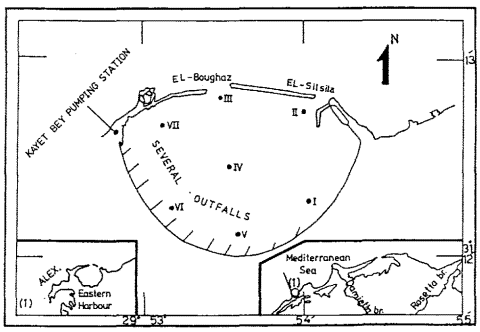

Fig. 1.- Sampled stations in the Eastern Harbour during the period 1985-1986.

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Chromium and Nickel in the Egyptian Mediterranean water

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Abstract

Seasonal and regional distribution of dissolved and particulate forms of Cr and Ni in the coastal and offshore waters of the southeastern Mediterranean basin off the Egyptian coast were studied throughout the year. High levels were observed in samples collected from nearshore areas specially at stations directly affected by continental runoff. The relating abundance of dissolved and particulate forms varied from inshore to offshore samples for each metal. The particulate concentrations of these metals were correlated with the total suspended matter and with some other metals (Al, Fe, Zn and Cu).

The total concentrations of the studied metals were comparable with other Mediterranean waters.

Introduction

The importance of studying chromium and Nickel lies on their toxic effect on living organisms, corrosive effect particularly chromates (BANERJEE, 1976) and their industrial uses. Cr and Ni compounds are involved in many technical processes; ;chromates are used in the textile, dyes and leather, tanning industries. Chromic acid is used as an oxidizing agent in organic technology. Hexavalent chromium compounds, which are poisonous constitute the main contaminant in the waste water of many industries (MANSOUR *et al.*. 1983 and ZAIDAN, 1983). Nickel compounds are also used in some industrial purposes, as Ni plating and tanning industries. Cr and Ni compounds are mostly used as alloys in electroplating and stainless steel industries (HOPIRTEAN *et al.*, 1983, ESPEUT *et al.*, 1983).

Material and methods

Twenty four sampling sites were chosen representing the deferent regions of the Egyptian coastal waters (Fig.1). Samples were collected using 10 liters PVC Niskin water sampler. Filtration and Analytical procedures were performed in a dust free clean lab. The technique described by TESSLER *et al.* 1979 was used in determination of total metal concentration associated with particulate matter ($HF/HClO_4$:5/1). After filtration, the preconcentration of dissolved metals was performed using a chelating ion exchanger resin (chelex 100) in ammonia form (ABDULLAH and ROYLE, 1974). Recoveries of Cr and Ni were 92% and 93% respectively.

Results and discussion

The average concentrations of Cr and Ni in dissolved and particulate forms are represented in Table I. The results showed that both metals exhibit clear differences in their distribution between near and off shore waters. Most nearshore waters lay in a higher concentration range than that of the offshore waters. The contribution of water discharged from landbased sources on the inshore environment is clearly reflected on the high levels of TPM and total metals in the neritic waters.

Despite the high toxicity of both metals, only few studies were made on the metal contents discharged to the Egyptian Mediterranean waters. The increased concentration discharged into the water are mainly attributed to the industrial sewage water dumped in the southern part of fresh water lakes.

The impact and magnitude of landbased sources on the inshore environment is clearly reflected on the high metal content recorded in the inshore zone specially in areas directly affected by their discharge. The coastal circulation pattern from west to east parallel to the coast does not permit their long - term accumulation in such areas. When water loaded with metals and nutrients discharged from different sources reaches El-Tina Bay, following the eastward circulation in the coastal zone, the shore configuration and circulation pattern in this bay (anti-clock wise gyre) renders it a store or trap for most metals and nutrients anthropogenically discharged to the area. This explains the appearance of high concentrations of the studied metals in areas far from any direct or brackish water discharge.

The behaviour of both metals tword the other elements were also studied, and showed intrcorrelations with certain metals (Table.2). The significant correlation between Cr and Ni (r=0.755) may indicate that both metals are mostly of the same origin. The ultimately correlations of both Cr and Ni with the other metals particularly Zn, Fe, Al and Cu may explain the wide use of both metals in different industrial purposes as described by DRAGO *et al.* 1983.

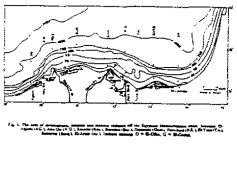
From the biological point of view Cr found at low levels in most biological materials with no evidence of accumulation at any point of the cycle.

Table (1). range, mean concentration (ng/1), standard deviations, number of samples and percent of dissolved metals in the Mediterranean waters of the study area.

METAL	CR	% OF DISSOLVED METAL (CR)	Ni	PERCENT OF DISSOLVED METAL (Ni)
DISSOLVED				
Winter (January)	14-170 66.33 ± 54.9 n = 23		0 - 495 215.78 ± 149.46 n = 23	
Spring (April)	7-21 13.27 ± 4.53 n = 11	17.68%	0 - 101 32.82 ± 25.25 n = 11	53.01
Summer (August)	6 - 14 9.0 ± 2.6 n = 8	14.67%	7 - 59 20.625 ± 19.03 n = 8	45.27%
PARTICULATE				
Spring	6 - 164 61.78 ± 46.43 n = 23		3 - 143 29.09 ± 37.32 n = 23	
Summer	20 - 100 52.36± 35.55 n = 14		3 - 83 24.93 ± 21.50 n = 14	

Table (2). correlation coefficients (R) of Cr and Ni with the other different metals in the study area.

METALS	R
Cr - Si	0.642
Cr - Al	0.697
Cr - Cu	0.628
Cr - Ni	0.755
Cr - Zn	0.724
Cr - Mn	0.580
Cr - Fe	0.481
Cr - Pb	0.617
Ni - Si	0.548
Ni - Al	0.633
Ni - Cu	0.641
Ni - Zn	0.718
Ni - Mn	0.703
Ni - Fe	0.431
Ni - Pb	0.415



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Dispersion Models and Behaviour of Some Trace Elements in Brackish Waters of an Estuary (Mex Bay)

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Mex Bay-west of Alexandria, is one of the Mediterranean bays. It receives effluents from three different landbased sources. Umum Drain (an agricultural drain) is considered as the greatest. Its discharge represents over 96 % of the total input. EL-RAYIS *et al.*, (1984) and EL-GINDY *et al.*, (1986) showed that Mex Bay is characterized by two water layers ; an upper brackish layer of salinity values ranging between 5 and 38.8 ‰ and lower saline layer. During spreading of the fresh water in the surface layer, the concentration of any element discharged with the fresh water may or may not follow the freshwater-seawater distribution, depending on wheather the elements are conservative or non-conservative (EL-RAYIS, 1990).

The present work is an attempt to study the distributions and ideal dispersion models of some trace elements and assessing their behaviours during the transportation process from Umum Drain to the proper sea via the estuary, following the procedure used by EL-RAYIS (1990). The results reveal the presence of a plume-like pattern directly off the drain outlet, in which the dissolved trace elements behave non-conservatively. Some of the elements, like Fe, Mn, Hg and P show considerable loss while others like Cu, Zn and organic carbon (OC) show slight enrichment than their counterparts found in the conservative dispersion models (Fig. 1). Both P and OC are originated mainly from the drain. In addition to the drain other sources in the region (Chlor-alkali Plant, CAP ; Western Harbour, WH ; and Dredging Activity, DA, Fig. 1) are contributed to the presence of the other elements in the bay. It is estimated that the drain alone contributes between 60 and 99.7 % of the total input of the trace elements to the bay.

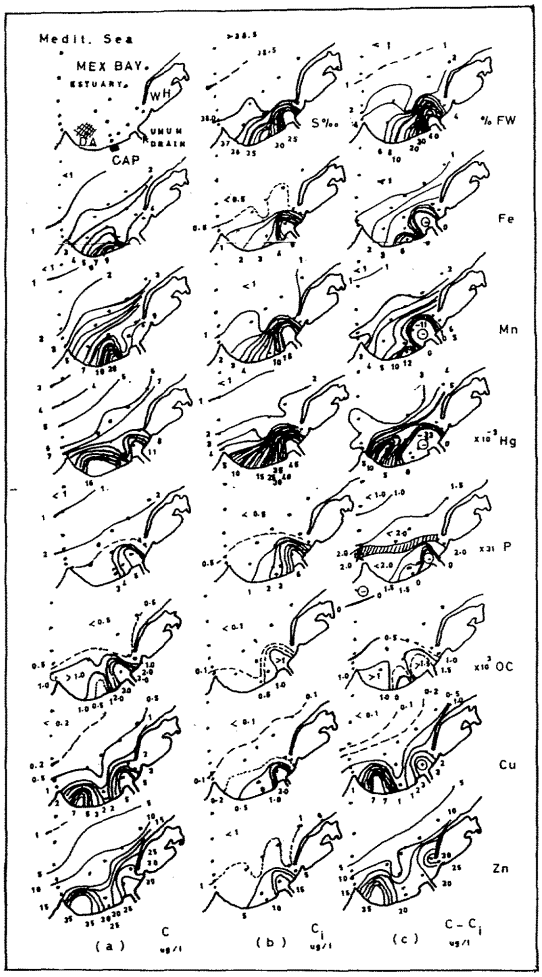

Fig. Distribution of (a) measured element C; (b) Calculated theoritical dilution line value of the element C_i; and (c) the difference between C and C_i, of the element in the surface brackish water of Mex Bay Estuary.

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Geochemistry of Mn anomalies in the surficial bottom deposits of the Sea of Marmara

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Six box-cores, one boomerang core, and two hundred-nine grab samples were collected during the 1984, and 1988-1990 cruises of R.V. *Bilim* and the 1988 cruise of R.V. *Knorr* across the Sea of Marmara (Fig.1) in an attempt to establish the metal levels in the surficial sediments and the factors controlling their distribution within the basin; these were analyzed for grain-size distribution and organic carbon, carbonate and metal contents.

The sediment composition varies regionally and in response to textural variations and the heavy metal composition of sediment samples, determined for Fe (0.42-6.31%), Ni (6-161 ppm), Zn (20-180 ppm), Cr (5-174 ppm), Co (7-30 ppm), Cu (6-92 ppm), and Pb (8-94 ppm), can be largely explained by admixture of terrigenous components of variable composition and biogenic components poor in metal contents (BODUR M.N. and ERGIN M., 1991). The usually high concentrations of metals studied occur in the fine-grained sediments. Mn (152-9127 ppm) was found to be enriched in the deep-sea sediments of Marmara Trough (Figs. 2 and 3) over the possible contributions from terrigenous sources and the results indicate that there is no significant hydrothermal contribution of Mn to the sediments. In particular, the enrichment of Mn in the surface layers and the downcore changes of color from reddish-brown to greenish-grey is interpreted as reflecting the postdepositional remobilization/precipitation processes as a result of redox changes within the sediment column. The interelement relationships in the sediments indicate similar sources for all the metals analyzed, except for Mn, that seems to be enriched owing to the diagenesis and hydrogenesis within the oxygen-depleted deep basins of the Sea of Marmara.

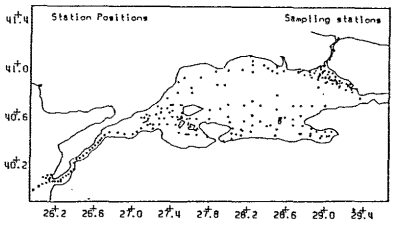

Fig.1. Sampling stations for surficial sediments in the Sea of Marmara.

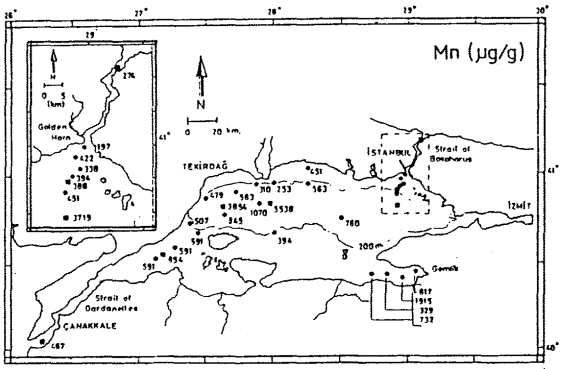

Fig. 2 . Distribution of Mn concentrations in the surficial Marmara sediments.

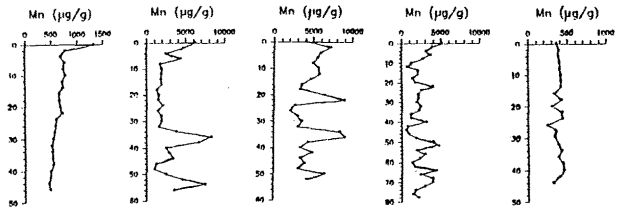

Fig. 3 . Downcore distribution of Mn concentrations in the Recent sediments across the Sea of Marmara, towards the Aegean Sea (left) and Black Sea (right) exits. Note the high Mn contents in deep-sea sediments.

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Reconnaissance study of heavy metals in surface sediments from the Southern Black Sea Shelf and upper slope

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A wide variety of sediment types (mud to sandy gravel) was obtained at fourty-seven stations on the Southern Black Sea shelf and upper slope and analyzed for their heavy metal geochemistry. Distribution of grain size, carbonates, organic carbon, and heavy metals show marked changes in the topography-related hydrography, biological activity, and land-geology of the region studied.

Sediments constitued up to 39% $CaCO_3$ mainly of biogenic origin from the shell remains of benthic organisms. Organic carbon contents of the sediments (0.13-3.09%) usually reflect the prevailing high primary productivities in the Black Sea although significant terrigenous influences are also inferred. The effects of both water currents and benthic activities on the grain size of sediments appeared to be important especially in the vicinity of Bosphorus Strait.

The heavy metal concentrations (Fe: 0.23-4.90%; Mn: 112-1064 ppm; Co: <1-20 ppm; Cr: 13-224 ppm; Ni: 11-202 ppm; Cu: 15-82 ppm; Zn: 24-138 ppm; Pb: 12-66 ppm) largely indicate the influences from the naturally-occurring geological sources delivered via river runoff and coastal erosion. In comparison with the average sedimentary rocks and other modern sediments from the adjacent regions YUCESOY and ERGIN, 1991, and many other references therein), the concentrations of Cr, Ni, Cu, Zn, and Pb are somehow higher in the surface sediments from Southern Black Sea. In particular, Cr (Fig. 1), Ni and Cu (Fig. 2) are found in high abundances in the Eastern parts of the study area. This is thought to reflect not only the well-mixed fine-grained nature of the sediments but also the possible contribution from metal-rich rocks (mafic and ultramafic sources) and associated economic mineral deposits in the catchment areas of rivers which drain this part of the coast. The presence of significant positive correlations between the concentrations of Cr and Ni, and Zn and Pb (Fig. 3) strongly suggest common sources and/or similar enrichment mechanisms for these metals. The relationships among the geochemical variables revealed that Fe, Mn, and organic phases together with the clay- and silt-sized grain fractions are the important associations of the studied heavy metals. Heavy metal data indicate that there is no significant anthropogenic contribution to the bottom deposits.

Fig. 1. Distribution of Cr in surface sediments along the Southern Black Sea Margin.

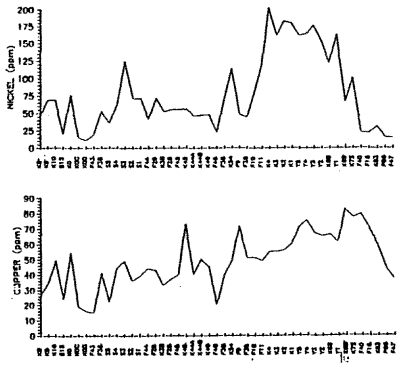

Fig. 2. Distribution of Ni and Cu in surface sediments along the Southern Black Sea Margin.

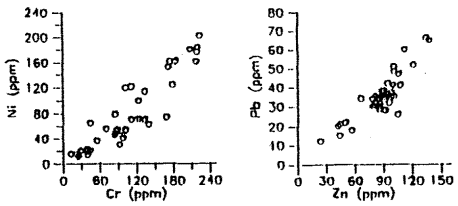

Fig. 3. Relationship between the concentrations of Cr and Ni, and Zn and Pb in surface sediments along the Southern Black Sea Margin.

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C

Spectrofluorimetric applications for the study of extracellular algal exudates

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The phenomenon of the appearance of massive quantities of gel aggregates recently affected the Northern Adriatic Sea in the summer seasons 1988-89-91, and covered a surface water area estimated at over 10,000 km2. Such gel formation is attributed to the hyperproduction of extracellular algal exudates (MARCHETTI *et al.*, 1989). The ability of phytoplankton to produce gel-forming material is genetically determined, but its formation in large amounts depends on the physiological state of the cells (FOGG, 1990). The increase in the production of organic extracellular material by planktonic marine diatoms is attributed by some authors to nutritional stress, such as an unbalanced N/P ratio (MYKLESTAD, 1989). However, the environmental factors which regulate the release of these substances have not yet been clearly defined. A need for further investigation aimed at a better understanding of the mechanism of potentially gel-forming exudation is generally recognized. With this aim, in the present study, the use of fluorimetric techniques for the analysis of both the gel material taken in the field and the extracellular substances produced in laboratory cultures was considered. The technique chosen was the synchronous fluorescence spectroscopy, which involves the stepping of both the excitation and emission monochromators of the spectrofluorimeter at the same time, while monitoring the emission, keeping a constant wavelength difference between the monochromators (LLOYD, 1971). This approach, compared to conventional spectrofluorimetry, allows the narrowing of spectral bands and for this reason it is appropriately employed for the analysis of multicomponent mixtures containing fluorescent compounds, and in particular for the determination of dissolved organic matter (VO-DINH, 1978; VODACEK, 1989).

An aliquot of the gel material taken in July 1991 in surface waters offshore from Cesenatico was analyzed following filtration of the sample (0.22 µm). At the same time, a gel sample taken in July 1989 from the same area, using the dried mass on the extracts of which chemical analyses had already been undertaken (MARCHETTI *et al.*, 1989) was also analyzed. This mass was in turn extracted with distilled water for fluorimetric analysis following filtration. The synchronous ex-em fluorescence spectra of both samples are given in Fig.1, and show an evident similarity of the peaks around the wavelength of about 280 nm. Batch laboratory cultures of *Skeletonema costatum*, a marine diatom from the Northern Adriatic coastal waters, were gently filtered and the analyzed suspension medium showed fluorescence in the same region (Fig.1). Furthermore, the spectral responses of various carbohydrate solutions fell precisely in the same region. These results are in agreement with the chemical characterization of both gel (MARCHETTI *et al.*, 1989) and algal exudates (MYKLESTAD, 1989). Although the present study does not take into consideration the individuation of the single exudated compounds, which are species or strain specific (FOGG,1990), the mentioned ex-em spectra reveal the presence of organic extracellular substances potentially capable of forming gels, in dissolved state. Thus, in order to verify the application to the study of the production trend in laboratory algal assays, aliquots of *S.costatum* cultures were taken at regular intervals along the algal growth curves for microscopic cell counts and fluorimetric analysis of the filtered medium. In replicated assays, results indicated an increase of organic matter dissolved in the medium during the log phase of the algal growth, with spectral characteristics identical to those in figure 1.

This series of preliminary verifications suggests that the synchronous fluorescence technique might be applied to study the factors which affect the production of extracellular organic substances in laboratory algal assays. A parallel field investigation monitoring the production trend is in progress. The proposed fluorimetric technique, new in the environmental studies, has important advantages: it is a simple method which can be used on a routine basis, without resorting to techniques which are more expensive and excessively time consuming (VO-DINH, 1978). Further investigations regarding both the quantitative and the analytical aspects, by parallel verifications with chemical analyses, are under way in order to confirm the validity of this method.

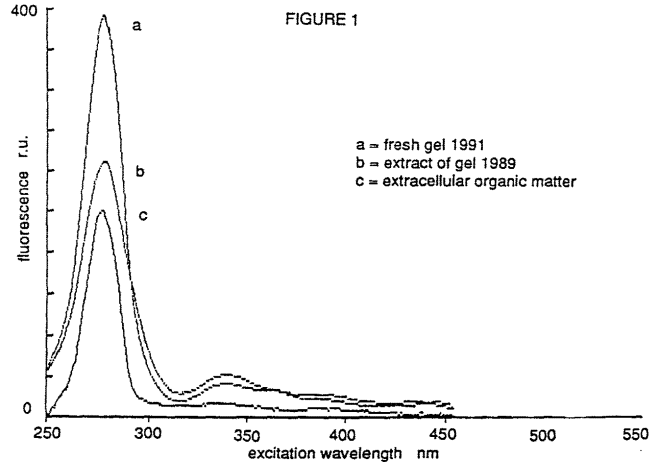

FIGURE 1

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Dissolved trace metals in Ligurian, Tyrrhenian, Ionian and East Atlantic deep-waters

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This work has been done during the 15th geochemical and geophysical Scientific Cruise (April-June 1984) aboard R/V*"AKADEMIK PETROVSKI"*, and the participation of the author within the IOC/UNESCO programme "X.4 - Ocean and its resources". A total of 78 surface and bottom water samples were collected from the open mid-eastern Atlantic Ocean (35°- 36°N and 12°-14°W), Ligurian, Tyrrhenian, Ionian and Maltese Seas (33°-44°N and 8°-28°E) with two stations in front of Genova and Monaco; Eight sampling stations from the Atlantic Ocean and twenty five stations from the Mediterranean Sea. The trace metals Cu, Zn, Pb, Cd, Ni, Co, Cr together with Mn, Fe, Li, Sr were determined in water samples.

Water samples were collected with pre-treated polycarbonate samplers. The sampling, processing and analysis were performed under strict clean conditions. The seawater samples were acidified with "suprapur" HNO_3 (1:1) and stored at 0°C in 0.5 - 2L acid-leached quartz bottles on board the ship, until measurement in onshore laboratories. No filtration of samples was performed because of the low amount of particles in open Mediterranean waters and due to the potential of contamination. A "Hitachi 180-70" double beam polarised Zeeman atomic absorption spectrophotometer was used to analyse the metals. All methods applied are described in detailed elsewhere (HANNA, 1985).

Details of the analytical results will be presented in the oral and/or the poster sessions at the congress, together with the exact location and the total depth of the sampling stations. This study showed that the concentration (µg L^{-1}) ranges and the grand averages from surface and bottom of all stations (together with ± standard deviation) were 0.08-0.05 (0.063 ± 0.1), 0.06-0.18 (0.086 ± 0.02) for Mn; .26-.45 (0.33 ± 0.6); .25 - 1.44 (.42 ± .12) for Fe; 0.11 - 0.14 (0.124 ± 0.01), 0.11 - .14 (0.124 ± 0.01) for Li; 3.7 - 4.8 (4.1 ± .2), 3.8 - 4.8 (4 ± .11) for Sr; 0.05 - 0.1 7 (0.093 ± 0.05), 0.05 - 0.1 7 (0.093 ± 0.05), 0.05 - 0.1 7 (0.11 ± 0.03) for Cu; 0.05 - 0.15 (0.08 ± 0.015), 0.04 - 0.11 (0.12 ± 0.06) for Zn; 0.3 - 0.6 (0.49 ± 0.1), 0.4 - 0.6 (0.5 ± 0.05) for Pb; 0.03 - 0.09 (0.075 ± 0.01), 0.07 - 0.1 (0.087± 0.01) for Cd; 0.26 - 0.36 (0.3 ± 0.02), 0.2 - 0.7 (0.36 ± 0.03) for Ni; 0.6 - 0.9 (0.76 ± 0.1), 0.6 - 0.9 (0.8 ± 0.04) for Co and 0.01 - 0.06 (0.06 ± 0.01), 0.04 - 0.1 (0.07 ± 0.01) for Cr (the values for surface and bottom respectively for each element).

The elements concentration of the open Mediterranean sea water samples are close to oceanic results gathered under similar conditions (except for Cd and Pb). These results indicate that a serious metal pollution problem does not exist in the open Mediterranean sea water so far at that time.

The elements Li, Sr, Pb, Co, Cr had bottom/surface ratio of the concentration values one and Mn, Fe, Zn, Ni had up to 1.4 values and Cu the only element which had a ratio of 1.9. This study show that the shap of the Mediterranean profiles differ from other findings in the open ocean (e.g. Pacific and Indian Oceans) by two main features. Firstly, no increase with depth, secondly, in average, much lower concentrations have been found in bottom waters of the Mediterranean than in Pacific or Indian Ocean bottom waters. (BOYLE *et al.*, 1975, 76; DANIELSSON, 1980; WESTERLUND OHMAN, 1991). I believe that these characteristics are mainly caused by the special hydrochemical conditions and biogeochemical processes prevailing in the Mediterranean Sea, (low nutrients and vertical mixing). These results indicate that little biological oxidation occurs in Mediterranean deep waters. Moreover, due to the low primary production, the processes of thermalhaline vertical convections (STOMMEL, 1972) and the relatively high turnover rate of the deep water do not allow enrichment comparable to those measured in Pacific waters. This assumption does not implicit that a biologically mediated transport from surface waters does not occur for these elements in Mediterranean. I suggest, and are supported by other authors (KREMLING & PETERSEN, 1981) and model calculations (TOPPING, 1974), that the overall analytical precision has to be much better than 5% to identify biologically mediated variations of trace metals in Mediterranean waters.

The overall mean concentrations of all elements determined in this study fit in very well with data reported by other authors (UNEP, 1985) for the world oceans. This supports the conclusions already made by BERNHARD (1978), KREMLING and PETERSEN (1981) that trace metal concentrations in seawater of the open Mediterranean do not seem to be much different from other oceans. I do hope that my data serve as a useful help for establishing the actual baseline concentrations in the Mediterranean sea environment.

Acknowledgments:

This work was supported by the IOC/UNESCO grant to the author to participate in the 15th Cruise of R/V *"AKADEMIK PETROVSKI"* and the visit to Moscow State University to undertake this work, Contract No. SC/RP 206076.5. Thanks are also due to professor U.K. BURLINE, Dr. U.N. GORSKY and Ms. T.G. SOKOVI of Moscow State University for their great help in the sampling and analysis of the samples.

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Cadium, Chromium, Lead and Manganese content in sediment of the Gruz Bay

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The determination of the metal content in sediment of a particular environment is essential for the assessment of its pollution levels. Vertical distribution of metals in sediment, if appropriately determined, may provide historical background of pollution.

The Gruz Bay is situated in the eastern part of the southern Adriatic (near the town of Dubrovnik) (Fig. 1). The area has its special features due to its geomorphological, hydrographic, chemical and biological properties which distinguish it from the similar bays on the eastern Adriatic coast.

This peculiarity is due to a variety of factors of which river Rijeka Dubrovacka freshwater input and strong influence of the open sea are most important. The major contributors to this area are industrial waste waters and smaller amounts of domestic sewage and precipitation run-off. Sediment of the Gruz Bay is formed of two layers. The upper layer (mud) contains very high quantitites of organic matter, its thickness ranging from 0.5 to 5 m. The other layer is formed of clay with fragments of lime-stone. Sediment samples were collected from seven stations (depth range 5-40 m). Five-cm fragments of 54 to 300 µm fraction were analyzed for metal content and percentage of organic substance.

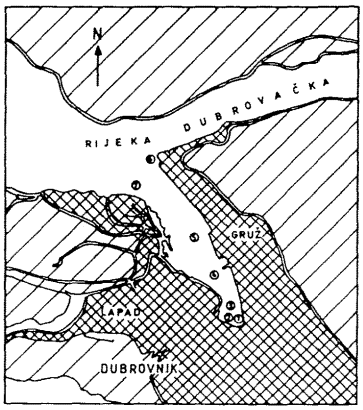

Fig. 1. Study area with station positions

Electrochemical atomic absorption spectrometry was used for Cd, Pb, Cr and Mn determination on Perkin-Elmer atomic absorption spectrophotometer, Model 1100B, with a HGA-700, graphite furnace and AS-70 autosampler system.

Organic matter content was very high, ranging from 8 to 28%, in all parts of the bay. The highest level was recorded from the bottom of the bay in the vicinity of municipal and industrial sewage outfalls. This level was reduced going towards the centre of the bay.

Spatial distribution of cadmium (0.02-3.43 µg g^{-1} DW) and lead (6.98-357.42 µg g^{-1} DW) significantly varied. Like for the organic matter, the highest quantities were recorded from the inner part of the bay, at stations 1, 2 and 3 (Fig. 2). This is quite normal since that area is strongly affected by municipal and industrial waste loads. At the same time manganese content (6.98-357.42 µg g^{-1} DW) is higher towards the bay outlet which is indicative of the fact that pollution loads there largely derive from the river Rijeka Dubrovacka inputs (Fig. 2). Chromium content (95.14-273.99 µg g^{-1} DW) is highest in the central part of the bay (Fig. 2). Even though this may be due to the vicinity of the town port, presumably chromium here is of terrigeneous origin.

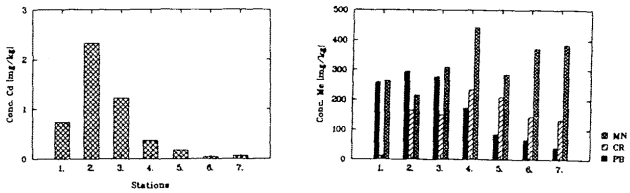

Fig. 2. Mean metal concentrations

Since the effects of organic matter on metal contents has been proved, the relationship between organic matter content and individual metals has been determined.

Table 1. Relationship between metal concentration and organic matter content expressed by linear equation: **metal conc. = a + b x org.matter(%)** (r is the correlation coefficient, P significance of correlation).

Metal	a	b	r	P
Cadmium (Cd)	-0.592	0.090	0.536	0.005
Lead (Pb)	55.604	7.930	0.417	0.034
Chromium (Cr)	218.148	-3.508	-0.325	0.105
Manganese (Mn)	452.371	-8.055	-0.494	0.010

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The significance of outlying P-PO_4 values in eutrophication studies

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The existence of "extreme", "doughtful" or "anomalous" values in collected data of nutrients from the natural environment have been characterized as "outliers" or outlying values (BARNETT and LEWIS, 1987). Outliers are often seen as reducing and distorting the information provided by the data and in this case they might be removed (EVERITT,1981). On the other hand, outliers might characterize extreme conditions of an ecosystem associated with pollution problems and thus, their presence should be taken into account in any statistical analysis concerning eutrophication assessment and coastal management.

In the present investigation outliers in nutrient (P-PO_4) data sets were identified and their spatial and temporal distribution was examined. Sampling was carried out monthly from 9 stations of Saronikos Gulf, Aegean Sea during 1981 (Fig.1, A). The net of these stations covered an area characterized by strong nutrient gradients (KARYDIS *et al.*, 1983) due to the influence of the sewage outfall. Outliers in the P-PO_4 data sets were detected by the method of "Box and Whisker Plot" described by TUKEY (1977) and OTT (1988). Data points lying outside 1.5 times the interquartile range of the upper quartile were recorded as outliers.

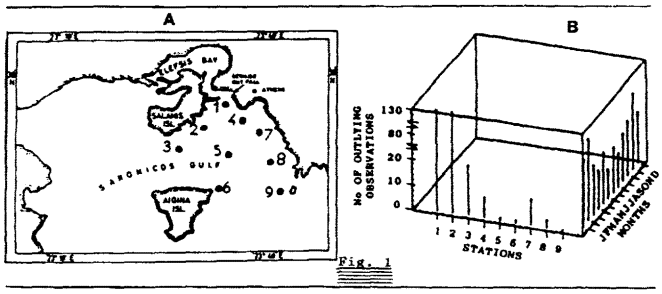

Fig. 1

Table 1. Distribution characteristics of the raw P-PO_4 data sets.

Data set	N	x	s	range
A. Before the exclusion of outliers	942	0.34	0.67	0.01-13.72
B. After the exclusion of outliers	697	0.12	0.08	0.01- 0.33
C. Outlier's set	245	0.96	1.10	0.34-13.72

The results on the distribution characteristics of the parent data sets of P-PO_4 are given in Table 1. It is seen that the original number of the raw data (N=942) was reduced (N=697) after the exclusion of outliers (N=245). The raw data and the outliers were further classified per station in an attempt to evaluate the contribution of each station in the entire set of values before and after the exclusion of outliers. The results showed (Table 2) a well defined gradient in the distribution of the number of outliers and their mean values which seems to be related with the vicinity of the corresponding stations to the sewage outfall. For example, the highest scores of outling values (129) and their mean (1.29 µg-at $P.l^{-1}$) were recorded at station S1 which was located near the sewage outfall and has been characterised as strongly eutrophic (IGNATIADES *et al.*, in press) and they diminished gradually along with the distance of each station from it. Also, at station S1, the outlying values comprised the 75% of the total recorded observations from this station whereas this percentage diminished again along with the distance of each station from the sewage outfall. A graphical presentation of the distribution of outliers at the 9 stations is given in Fig. 1B, along with their seasonal distribution. It is seen that seasonality might also play an important role in contributing outlying values in the P-PO_4 annual data.

Table 2. Summary statistics of the raw and outlying values of P-PO_4 data sets per station.(N=total No of observ.,x=means, s=stand.dev.)

	Raw data (r)			Outliers (o)			% Outliers over Raw data	
	N(r)	x(r)	s(o)	N(o)	x(o)	s(o)	N(%)	x(%)
S1	173	1.00	1.29	129	1.29	1.38	75	77
S2	174	0.35	0.30	74	0.60	0.31	43	58
S3	174	0.18	0.20	19	0.54	0.41	11	33
S4	72	0.17	0.41	8	0.81	1.02	11	21
S5	71	0.12	0.09	1	0.41	-	1	29
S6	72	0.10	0.07	1	0.40	-	1	25
S7	68	0.16	0.19	10	0.55	0.21	15	29
S8	69	0.12	0.14	3	0.68	0.22	4	18
S9	69	0.09	0.04	0	-	-	0	27

The results of this work indicate the possibility of using outliers as an index of eutrophication and applying statistical tests among outlying data as a means for detecting differences concerning nutrient loadings in the marine environment.

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The pathways of uranium reduction in the marine environment

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In the marine environment and natural waters in general, three well defined oxidation states of uranium are present and coexist under appropriate conditions of redox potential and pH. Classic geochemistry interprets the biogeochemical cycle of uranium in natural waters and sedimentary environments in terms of the rather simplified concept of "soluble uranium(VI) - insoluble uranium(IV)". This perception works comparatively well for a wide range of uranium's thermodynamic equilibria in oxygenated aqueous solutions, so that the two less stable oxidation states of uranium, III and V, were not regarded as being of significance in natural waters. Uranium(III) certainly is much to strong a reducing agent to persist in natural aquatic environments, but U(V) is a possible intermediate redox species. However, the UO_2^+ species is rather unstable in the realm of natural Eh and pH conditions and quickly disproportionates between the oxidation states VI and IV. A further handicap is the analytical difficulty of distinguishing between the U(V) entity and a mixture of the redox states of U(IV) and U(VI). The instability of this aquatic species renders solution-based analytical methods (spectrophotometry, emission and absorption spectroscopy) unsuitable for experimental identification of uranium(V) - regardless of their sensitivity or degree of instrumental sophistication.

Dissolved uranium is removed from the oceans primarily by diffusion across the sediment-water interface of organic-rich sediments (Klinkhammer and Palmer, 1991). It is thus obvious that the redox shifts of the coexisting oxidation states of uranium in seawater and sediment (particularly along the redoxcline, and as a rule after iron reduction in the diagenetic sequence) will have a significant effect on the speciation, ligand interactions and surface reactions with various sediment matrices.

The geochemical equilibrium code MINTEQ.A2 was used to predict the solubilities of uraninite in model groundwaters and pure water. The predicted equilibria are influenced by dissolved uranium(V) species but vary considerably with the database used. A recently reevaluated value of 0.254 V for the standard redox potential of the U(VI)/U(IV) couple was used for the construction of appropriate potential-pH diagrams. The resulting stability field of the UO_2^+ ion is considerably larger. An "intrusion" of ca. 100 mV into the uranium(IV) predominance area, in the vicinity of the lower water stability fence, brings the UO_2^+ ion well into the reducing realm of Eh values. An extrapolation of this observation into conditions of Eh and pH prevailing in natural waters provides arguments for a greater geochemical role of uranium(V).

In the marine environment, the role of biomass in the equilibrium reactions of uranium has to be considered. Recent investigations have indicated that microbial reduction and the associated enzymatic precipitation of uranium are significant reaction pathways for its removal from seawater (GORBY and LOVELY, 1992). An additional challenge which needs to be addressed in further investigations is the influence of marine colloidal matter (of both inorganic and organic origin) on the redox reactions of dissolved uranium species. The concept of a thermodynamically stable U(V) species may be used to give argument to the still existing controversy over principal reduction mechanisms for uranium in the marine and sedimentary environment.

Since the scavenging (or diffusion) of uranium from seawater into suboxic sediment accounts for ca. 3/4 of dissolved uranium removal from seawater, uranium distributions may be used to estimate sedimentation rates in hemipelagic sediments and also as an indicator of paleoredox conditions.

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Metal speciation by selective adsorption

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Adsorptive stripping voltammetry of surface active complexes of metal ions and inorganic ligands can be utilized for the direct metal speciation if combined with the anodic stripping voltammetry.

A tendency in electrochemical speciation of metals is to actually measure the concentration of the particular ionic species, rather than calculating the distribution from thermodynamic data, as well as to measure it in the concentration range as close to its level in natural waters as possible (1). A progress in these efforts was achieved with inert metal complexes (2), and here a possibility of a direct quantitative measurement of a surface-active, labile inorganic metal complex is demonstrated.

Adsorption phenomena may influence voltammetric measurements significantly. Complex species of metal ions and surface active ligands can be adsorbed to the working electrode surface (3-5). For a certain metal and a certain inorganic ligand, only one complex adsorbs, usually the neutral, or negatively charged one (4). Generally, the phenomenon can be utilized for the adsorptive accumulation of surface active substances (3,5). In combination with stripping techiques especially sensitive to adsorbates, such as the square-wave voltammetry and the pulse polarography, this method enables the determination of reactants in concentrations as low as 10^{-9} M (5). In the case of metal complexation with inorganic ligands, the adsorptive preconcentration is selective since only one complex species is surface active. It will be shown that the combination of the adsorptive stripping and the anodic stripping voltammetric techniques can be used for the direct metal speciation. The anodic stripping voltammetry is used for the determination of total metal concentration. The amount of metal ions bound to the surface active complex can be determined by the independent adsorptive stripping voltammetric measurements. The character of this complex can be estimated by comparing to the theoretical ionic species distribution graph (4). Besides, an influence of electroinactive, competitive, surface-active substance, such as T-X-100, is demonstrated. Possible application to the speciation of Bi (III) in seawater is discussed.

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Adsorption of Cadmium and Lead ions on varied calcite concentrations from estuarine water and seawater

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Laboratory experiments on the adsorption of lead and cadmium on model phases improve our knowledge on the behaviour of these metal ions in natural aquatic systems. Recently, we have investigated their adsorption on calcite, in order to explain the distribution of these ions in the waters of the calcerous Krka River Estuary (1). The adsorption data obtained can be described by the S-1 type of empirical adsorption isotherm, rather then by the Langmuir's model. These curves were clearly incomplete because the saturation of the calcite surface in the systems studied has not been reached, so that the adsorption constants could not be calculated.

In the present work the particle concentration effect on the adsorption of lead and cadmium ions from estuarine water and seawater was studied. A Coulter Counter method was used to study the change of particle size and their specific surface area with the particle concentrations in the range between and $1x10^{-5}$ to $1x10^{-3}$ kg dm^{-3}. Measurements were performed in waters of different salinities, after equilibration of 24 hours. Results have clearly demonstrated that with an increase of particle concentration also increases the percentage of large particles. The indicated aggregation of the calcite particles consequently leads to a loss in the specific surface area.

Using the measured relationship between the concentration and the specific surface area of the calcite particles, the adsorption isotherms of cadmium and lead ions on calcite was reinterpreted and the values of the adsorption constants were obtained.

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The distribution of nutrients in the surface layer of the Krka Estuary

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The traditional method of reporting nutrient distribution in estuaries is their presentation against normalized salinity.

In the case of the Krka Estuary (Middle Adriatic Sea), which can be classified as a "salt wedge" type (Fig. 1.a), this method is also useful.

The information obtained can be immediately visible (Fig. 1.b) and as in the case of silicate allow a conclusion of its conservative behaviour .

The more frequent occurence given on the example of ammonia (Fig. 1.c) showes that basic direction of nutrient deviations along the estuary can also be observed, but the identification of the corresponding station, however, is difficult.

Figs. 1.e and 1.f show a modified representation of the nutrient deviations from their theoretical values, taking in account the station position.

This type of diagram appears to be useful in combination with other available parameters, i.e. Chl a (Fig. 1.d) (1).

Based on the data for the Krka Estuary in 1990 and 1991 (2), this paper demonstrates the non-conversative behaviour of nutrients in the surface layer and discusses their deviations.

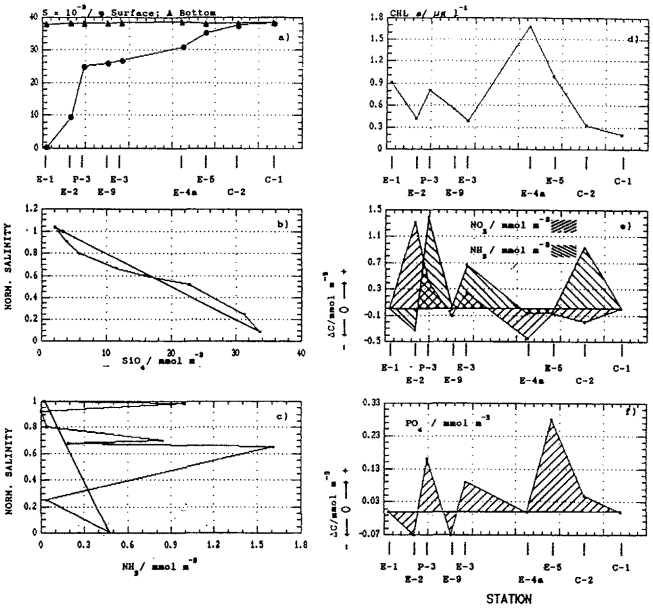

Fig.1. a) Salinity values in the surface and near bottom layer, b) Silicate against normalized salinity, c) Ammonia against normalized salinity, d) Chlorophyll a, e) Modified diagram of nitrate and ammonia deviations along the Estuary, f) Modified diagram of phosphate deviation along the Estuary.
All values are given for August 1990, exept silicate (April 1990).

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Behaviour of Alkylphenol Polyethoxylates in Krka River Estuary

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Due to the high production figures and unfavourable metabolic behaviour in the sewage treatment characterized by the formation of the lipophilic toxic metabolites (1, 2) alkylphenol polyethoxylates represent an issue of major environmental concern.

Input and distribution of alkylphenol polyethoxylates in the Krka River Estuary were studied during 1990-1991. Grab samples of wastewaters were taken from the sewering system of the town of Sibenik and at all major outlets in the Sibenik Harbour. In addition, samples of estuarine water were collected at different distances from the wastewater outlets and from the vertical profile of the water column.

Quantitative determination of APnEO was performed by high-performance liquid chromatography (HPLC) involving both normal-phase (distribution of oligomers) and reversed-phase (distribution of homologues) systems (3). The dissolved APnEO (filtered through GF/F filters) were extracted using C_{18} cartridges (4) while the particulate APnEO were extracted using an ultrasonic method.

The concentrations of APnEO in the wastewater varied in a rather wide range from 43-2960 /µg/L. The oligomer distribution was relatively uniform in all of the examined wastewater samples and indicated the predominance of the APnEO which are common for laundry detergents (Fig. 1). The most abundant individual oligomers in the dissolved fraction were those having an average number of EO units per molecule of 9-11. The oligomer distribution in the particulate fraction was significantly different showing a shift of the maximum towards lower oligomers (nEO = 6).

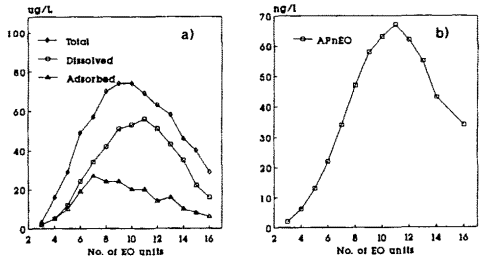

Figure 1. Oligomer distributions of alkylphenol polyethoxylates in a) raw wastewater and b) composite sample of the estuarine water from the vertical profile in the Sibenik Harbour

The study of the horizontal distribution of APnEO suggested that simple dilution was the primary mechanism which caused their rather low concentration levels in the water body of the Sibenik Harbour.

Fast sedimentation with sewage derived particles was indicated as another important mechanism since a significant portion of the total APnEO in the wastewaters (from 11.4 to 61.7 %) was found in the particulate fraction.

The vertical distribution of APnEO in the water column reflected clearly the stratification of the Krka River Estuary. The concentration maxima of APnEO were determined in the surface microlayer (17.1 /µg/L) and at the boundary of the freshwater and salinewater layers (8.6 /µg/L) while the concentration in the underlying salinewater layer was low (< 1 /µg/L). This indicated that the vertical transport of the pollutants was greatly reduced by the freshwater-salinewater boundary.

The oligomer distribution of APnEO in the estuarine water (Fig. Ib) resembled very closely the distribution of the dissolved APnEO in the wastewaters thus suggesting no significant alteration of the original composition by biodegradation. Indeed, the model biodegradation experiments conducted in the laboratory have shown that the biodegradation half-life of APnEO was in the range from 9 to > 25 days depending on the origin of the bacterial culture (freshwater or salinewater layer) and temperature (Fig. 2). The biodegradation was particularly slow in the salinewater layer and under the winter temperature conditions.

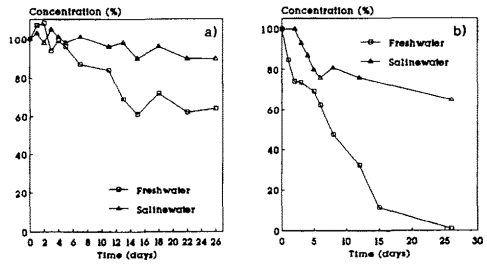

Figure 2. Model biodegradation experiments conducted with two different mixed bacterial cultures from the Krka River Estuary under the a) winter (13 °C) and b) summer (22.5 °C) temperature conditions.

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"On spot" Collection of reactive Mercury

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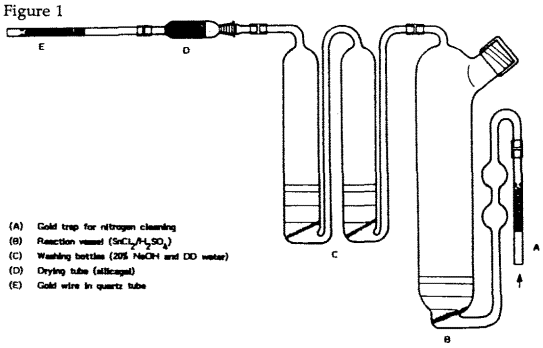
A single device for the reduction of mercury from the samples and its collection in the elemental form onto gold wire is illustrated in Fig. 1.

Figure 1

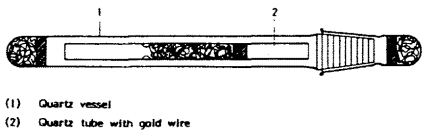


A method has been applied on the vessel or on-shore within few minutes of sampling, taking into consideration wind direction and lee-side, respectively.

Water samples were taken into a reaction vessel containing a $SnCl_2$ and H_2SO solution where mercury was isolated from the solution after reduction by $SnCl_2$. The mercury was passed over gold wire using extra pure nitrogen as purging gas and sample carrier, and was subsequently amalgamated.

The gold wires with the deposited mercury were stored for several months in a well-protected, closed quartz vessel (Fig. 2), with no significant changes in mercury concentrations (Table 1). Measurements were performed using cold vapour atomic absorption spectrometry (CVAAS).

Figure 2.



The samples were collected (Sibenik Aquatorium, Adriatic Sea, Croatia) by a diver facing the current direction, thus practically excluding "classical" problems associated with the sampling procedure (1).

In the estuarine water layer of lower salinity the reactive/total mercury ratio was between 0.1 and 0.5, whereas in the estuarine water layer of higher salinity the ratio was between 0.8 and 1.0 as in "clean" coastal seawater (2,3).

Table 1. Reactive mercury concentrations after collection and storage on gold wire

Place of sampling	Date of sampling and collection of reactive Hg onto gold wire	Reactive Hg concentration (direct measurement) ng/l	Date of measurement of reactive Hg collected and storage onto gold wire	Reactive Hg concentration ng/l	n
Krka River Estuary (E) S= 19‰	17.09.1990	0.55 (Total Hg 1.1)	19.09.1990 (2 days)	0.5±0.1	4
			28.09.1990 (11 days)	0.6±0.2	4
			04.12.1990 (77 days)	0.6±0.2	4
Zlarin Island outer side of coastal zone (C) S=37‰	22.09.1986	0.30 (Total Hg 0.32)	25.09.1986 (3 days)	0.31±0.05	4
			10.10.1986 (18 days)	0.25±0.05	4
			07.11.1986 (46 days)	0.28±0.03	4
			24.11.1986 (63 days)	0.20±0.02	4

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Theory of Cathodic stripping square-wave voltammetry

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Kinetic parameters for redox reactions of reactants immobilized at the working electrode surface are k_s/f, if a product is also immobilized, and $k_s/f^{0.75}$ if the product is soluble.

Cathodic stripping voltammetry is a valuable analytical method for the determination of traces of electroinactive anions which can form a thin film of insoluble salt on the surface of a mercury, or a silver working electrode (1-5). The method has been used to analyse traces of halides (1,3) sulfide (2,4), selenide (5) snd some other substances (1). Detection limits reported for different anions vary from $5\text{-}10^{-9}$ M to $5\text{-}10^{-7}$ M, depending on the stripping technique applied. One of the most advanced electroanalytical techniques, the square-wave voltammetry, is especially sensitive to quasireversible redox reactions of reactants immobilized at the working electrode surface (6). The immobilization can be achieved by different processes, such as the direct, or anion-induced adsorption, the electrodeposition of metal atoms on solid electrodes and insoluble salts on the surface of mercury and silver electrodes, the amalgam formation within the thin mercury film covered glassy-carbon electrode, or by the abrasive transfer of traces of solid analyte onto a surface of a graphite rod. All these processes can serve as a preconcentration step of an electroanalytical method and usually are followed by the chathodic, or the anodic square-wave stripping scan. A model of cathodic stripping square-wave voltammetry of insoluble mercuric salt accumulated at the mercury drop electrode surface is developed.

Theoretical relationships between the properties of responses and the parameters of both the redox reaction and the SWV signal are analysed. Both reversible and quasireversible redox reactions are considered and the nature of the so called "quasireversible maximum" is discussed. Similarity between responses of reactants which are immobilized by different processes is demonstrated. The kinetic parameters of these redox reactions are shown to be k_s/f, if the product is also immobilized, and $k_s/f^{0.75}$ if the product is soluble. Here, K_s is the standard reaction rate constant and f is the SW frequency. Numerical simulations are compared qualitatively with the SW stripping voltammograms of electrodeposited Hg_2CL_2 and Hg_2Br_2. The application of the method to the measurements of halides in the seawater and S^{2-} in anaerobic waters is discussed.

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AAS - Determination of Mercury in marine reference materials after wet ashing by means of microwaves

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The application of microwaves (2450 MHz) to the mineralization of environmental samples for the purpose of the determination of mercury has been investigated.

The method was tested on 5 reference materials produced by the IAEA : MA-M-2/TM (mussel homogenate), MA-A-3/TM (shrimp homogenate), MA-B-3/TM (fish homogenate), IAEA-350 (tunny-fish, lyophilized) and SD-M-2/TM (deep-sea sediment). The concentration of mercury in these materials is either certified or known with an acceptable degree of accuracy.

The digester "Microdigest" - 300 (PROLABO) was used for the mineralization of these samples. Mineralization tests were done under various operating conditions : microwave energy, duration of operation, oxidizing reagents (HNO3 - H202 and HN03 - H2S04 - H202), condenser type (Vigreux column or Liebig column). Resulting solutions were analysed by cold-vapour atomic absorption spectrometry (HATCH 1 OTT, 1968). Results are given in Table 1. For each material the mean value of the individual determinations is compared with the consensus value (certified) or the expected value (non-certified). The agreement between these values is good (less than ± 10% deviation) in the case of shrimp homogenate MA-A-3/TM and lyophilized tunny-fish IAEA - 350 (the expected value for this sample was obtained in our laboratory by applying a conventional wet-ashing method). The mean value is lower than the certified value for the mussel homogenate MA-M-2/TM (-23%) and higher than the certified value in the case of the sediment SD-M-2/TM (+22%).

The applications of WILCOXON's non-parametric test showed that results of "strong attacks" (high microwave energy and long duration) are significantly higher than results of "weak attacks" for all analysed materials ($p < 0.01$). Results obtained by use of the Liebig condenser seem also to be higher than results obtained with the Vigreux column but the difference is less significant ($p < 0.10$). The effect of the addition of sulphuric acid is not systematic and depends on the material analysed.

Microwave mineralization coupled with cold-vapour atomic absorption spectrometry is a rapid and efficient analytical method for the determination of mercury in environmental materials. It takes about 15-30 minutes to solubilize mercury from the samples instead of several hours with the classical wet-ashing method.

Table 1. Results of Microwave mineralization

Sample N°	Oxidizing reagents (1)	Type of attack (2)	Condenser used
1	A	weak	Vigreux
2	A	strong	Vigreux
3	A	strong	Liebig
4	B	weak	Vigreux
5	B	strong	Vigreux
6	B	strong	Liebig

(1) A : 10 ml HNO3 65% followed by 2 ml H202 35%
B : 7 ml HNO3 65% + 3 ml H2S04 98% followed by 2 ml H202 35%

(2) weak attack : A : max energy 10%, duration 15 min.
B : " " 5%, duration 20 min.

strong attack : A : max energy 15%, duration 20 min.
B : " " 15%, duration 35 min.

Results of mercury determinations ($\mu g\ g^{-1}$)

Sample N°	MA-M-2/TM	MA-A-3/TM	MA-B-3/TM	IAEA-350	SD-M-2/TM
1	0.70	1.53	0.45	3.11	0.065
2	0.75	1.69	0.43	3.94	0.080
3	0.75	1.82	0.53	4.31	0.076
4	0.68	1.64	0.41	4.24	0.057
5	0.75	1.82	0.47	4.39	0.064
6	0.73	1.96	0.47	4.65	0.057
Mean value	0.73	1.74	0.46	4.11	0.066
Expected value	0.95(1)	1.79(2)	0.51(1)	4.42(3)	0.054(1)
Rel. deviation	-23.2%	- 2.8%	- 9.8%	- 7.0%	+22.2%

(1) certified (2) non-certified (3) conventional wet-ashing

Correlation : mean value (y) - expected value (x) :

$y = 0.938\,x - 0.028$ $r = 0.9987$ ($p < 0.001$)

C

Reactive and total Mercury in offshore waters of the Ligurian Sea

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Samples of seawater were collected in August 1991, during a cruise with the Oceanographic Vessel *N/O Minerva* (CNR, Consiglio Nazionale delle Ricerche). Sampling was carried out with acid cleaned borosilicate glass bottles at the following depths: 0.2, 5 and 10 meters. Salinity and temperature were recorded by bathysonde CTD ME (Meerestechnik-Elektronik) for all sampling sites. GPS equipment was used for vessel's positioning. Mercury determinations were done on unfiltered samples with the cold vapour technique after preconcentration over gold, with Atomic Fluorescence detection. The analytical methodology for total mercury (Hg-T) and the critical steps (sampling, storage of samples, samples pretreatement, and blank values) were described by MINGANTI *et al.* (1991). The detection limit of the method is 0.2 ng L^{-1}. Reactive mercury (Hg-R) was determined with the same equipment directly on board the ship without any pretreatment of the samples. Accuracy and precision of analytical determinations were evaluated, and results are shown in Table 1.

Table 1. Results obtained for total mercury determination on ORMS-1 Riverine Water Reference Materials for Mercury of the National Research Council of Canada. All results are in ng L^{-1}. Confidence limits (c.l.) are calculated at p% = 95 of confidence level.

Results obtained	BottleA:	5.1	5.5	5.6
	Bottle B:	6.5	6.2	
	x±c.l..	5.8 ± 0.7		
Certified value	x±c.l.	6.8 ± 1.3		

Sampling sites, togheter with a summary of Hg-T levels are shown in Figure 1. Increasing levels of mercury are represented with darker shading.

No correlation was found among Hg-T, Hg-R, salinity, temperature, and depth. Median, mean, standard deviation (S.D.), number of samples (n), minimum and maximum values for the parameters considered are reported in Table 2.

Table 2. Summary statistics and number of data for Hg-T and Hg-R (ng L^{-1}), Hg-R/Hg-T ratio, salinity (‰), temperature (°C).

	Median	Mean	S.D.	n	Min	Max
Hg-T	0.7	0.8	0.5	32	0.3	2.3
Hg-R	0.3	0.3	0.2	33	0.2	0.8
Hg-R/Hg-T	0.4	0.5	0.2	32	0.1	1.0
Salinity	38.105	38.133	0.108	21	37.982	38.293
Temp.	24.68	24.79	0.62	21	23.50	25.67

Levels found are lower than those reported by other authors for offshore waters of the Mediterranean. FERRARA and MASERTI (1986) reported values ranging 1-6 ng L^{-1}, with a mean of 4 ng L^{-1}.

Data concerning the outer part of the Estuary of River Krka (Adriatic Sea), reported by MIKAC et al. (1990), are lower, ranging 0.9-1.2 ng L^{-1}, at 38‰ salinity. Hg-R is about 90-100% of Hg-T, higher than what found in this work.

Data concerning Hg-T and Hg-R levels in offshore water of the Ligurian sea were reported by COPIN-MONTEGUT *et al.* (1986). No differences were reported between Hg-T and Hg-R, and mean level about 2.5 ng L^{-1}.

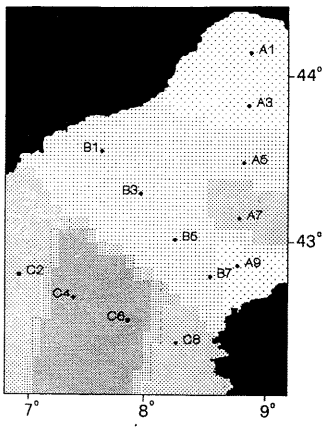

Figure 1. Sampling sites in the Ligurian Sea. Increasing levels of mercury are shown with darker shading

FILEMAN *et al.* (1991) in surface water samples from the Dogger Bank and the Outer Silver Pit (North Sea), reported a Hg-T mean level (as Hg-Dissolved + Hg-Particulate) of 0.4 ng L^{-1}, with 70% of Hg-R.

COSSA and FILEMAN (1991) in unfiltered surface waters of English Channel, reported a Hg-T concentration of 0.2 ng L^{-1} in Mid Channel, rising to 0.6 ng L^{-1} inshore. These values are in good agreement to the most recent measures in surface oceanic waters (Hg-T ≤ 0.5 ng L^{-1}), as reported by GILL and FITZGERALD (1987) and FILEMAN and HARPER (1989).

Acknowledgements

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Vertical Particulate Carbon fluxes in the Ligurian Sea : A time-series study

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In open Mediterranean waters the downward flux of particulate material may originate from either an allochtonous source (atmospheric fallout, terrigenous input) or an autochtonous source (export from the photic zone). The latter comprises particles basically originating from the primary production of particulate organic matter and the associated build up of mineral particles such as carbonates and opal. In the framework of the French JGOFS activities in the Mediterranean Sea (DYFAMED programme), a time-series study on particle, major and trace element fluxes in the water column was initiated in the Ligurian Sea in 1986 to ascertain the role and importance of these various sources. The importance and magnitude of the atmospheric input has already been discussed by FOWLER *et al.* (1987) and BUAT-MENARD *et al.* (1989). In the present paper we report data on the downward carbon fluxes, primarily those associated with primary production in the upper waters.

Since 1987, we have regularly monitored particle fluxes at two offshore stations out of the influence of the Ligurian Current, one near Corsica (42°44 N and 8°32 E, 1987-1988) and the other near the French Riviera (43°25 N and 7°52 E, 1988-1990). Automated sediment traps (models Technicap PPS-3; cylindro-conical; 0.125 m^2 surface opening and PPS-5, conical; 1 m^2 surface opening) were moored at 100, 200 and 1000 m depth, and samples were sequentially collected every 9 to 15 days. The sites were visited every three months both to check the mooring line and to exchange the sample collectors. Cup collectors were filled with a 2% buffered formaldehyde solution to prevent microheterotrophic activity and to limit the impact of leaching and autolysis on the collected particles. Swimmers were carefully removed by sieving and hand-picking using forceps under a dissecting microscope.

The carbon fluxes, like total particulate fluxes, varied substantially over time. Important and rapid changes in fluxes were normally recorded simultaneously at the three depths surveyed indicating a rapid settling of particles through the water column. The sinking velocities were estimated to be at least 60 to 90 m per day. Carbon fluxes were the highest in late spring, and maxima were recorded in June 1987, June 1988 and May 1990 (Fig.1). Winter carbon fluxes were also important but not as high as spring fluxes. Year 1989 was particular in that the maximum amount of sedimenting carbon occurred in winter and not in spring. In general, carbon fluxes were the lowest in autumn.

Since the 200 m trap was collecting particles under the euphotic zone and the mean vertical flux of organic carbon at that depth is generally considered to be equivalent to "export production" from the overlying waters, we discuss here only the 200 m data. The average carbon flux over the entire 4-year period was 14.7 mg m^{-2} d^{-1} and ranged from a minima of 2-4 mg m^{-2} d^{-1} to a maximum of 68 mg m^{-2} d^{-1} (June 1988). The organic carbon flux was relatively high and, at 200 m, had a mean value of 11 mg m^{-2} d^{-1} (ranging from 1 to 60 mg m^{-2} d^{-1}). For both total and organic carbon, the fluctuations in flux observed were considerable and varied over the year by a factor of 30 to 60. Aside from the general seasonal pattern, a pronounced variability on shorter time scales was also observed during the continual, high resolution flux experiments. For example, short pulses of enhanced sedimentation lasting only 48 hours were recorded in spring 1990. On an annual basis, total particulate carbon export from the surface layers was 5.1 g m^{-2} y^{-1} of which 4.0 mg m^{-2} d^{-1} was organic (POC, export production) and 1.1 mg m^{-2} d^{-1} was carbonate carbon. Total particle flux followed approximately the same pattern as the carbon flux, however, the highest mass fluxes occurred both in winter and in spring.

Vertical fluxes measured in the relatively unproductive Ligurian Sea (NW Mediterranean Sea) during the years 1987-1990 are of a similar magnitude as those reported for other oligotrophic oceanic waters. A seasonal signal in carbon flux is clearly observed and is related to both the seasonality of the physical environment (water column mixing in winter) and biological activity (spring phytoplankton bloom).

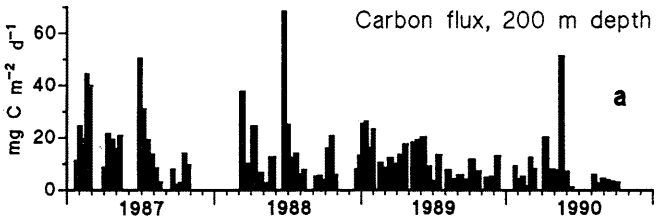

Fig. 1. Vertical flux of particulate carbon at 200 m depth in the Ligurian Sea, Northwestern Mediterranean, from 1987 to 1990.

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Eu(III) complexation with humic acid and similar ligands in natural waters

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Humic materials play very important role in the transport and sorption of metal ions in the environment, i.e. in seawater and fresh waters. Namely, as the nuclear energy industry still exsits in a great extent in the environment, fission products and actinide elements, such as europium, americium etc, could be released from the reactor operation, reprocessing plants and reprocessed waste disposal. Furthermore, concentrations of europium (III) in marine and fresh waters are frequently larger than predicted by the solubility products with hydroxide and carbonate concentrations normally present. Naturally occuring organic materials (humic and fulvic acid) are responsible for higher concentrations of these dissolved elements because of the complexation process. The interaction of europium(III) with humic acid (1-3) is very significant in the first place because it has properties which are comparable in a great extent with other characteristic radionuclides, i.e. americium(III) and plutonium(III). The strenght of the Eu(III) complexation with humic acid can be used as an example of the environmental behaviour of the actinides, as well.

Determination of Eu(III)-humate complex, as well as Eu-thenoyltrifluoroacetonate (TTA) and Eu-salicylate complexes by square-wave voltammetry was performed. The complexes are strongly adsorbed at the mercury drop electrode surface.

The main difference between them is the fact that the Eu-humate complex cannot be accumulated at the electrode surface, so it is not suitable for the analysis of lower contents of europium. Complexes of europium with 2-thenoyltrifluoroacetone and salicylic acid accumulate at the electrode surface so that low concentration levels of europium can be detected. With TTA, the concentration level of 5×10^{-9} mol/L of europium at pH = 6.6 was reached. With salicylic acid as a ligand the concentration level 10^{-8} mol/L of europium at pH = 5.3 was obtained. Europium - humate complex was determinated at pH = 5.0 and lowest europium concentration level reached was about 5×10^{-7} mol/L of europium.

It is interesting that the electrochemical process of these complexes proceed by totally different mechanisms what is the characteristic of europium in the various aqueous solutions and in the presence of various ligands.

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The influence of macrozooplankton on the fatty acid composition of particulate matter collected by sediment traps

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Zooplankton can affect significantly particulate matter vertical fluxes and modify the suspended and sedimenting particle composition (NOJI, 1991). In 1991, during a sediment trap experiment, carried out in the northeastern Adriatic sea, 25 km off Rovinj, the influence of macrozooplankton, probably mostly actively swum into traps (free swimmers), on fatty acid and hydrocarbon composition of entrapped material was investigated. Analyses were performed on total samples, samples free of macrozooplankton and isolated macrozooplankton (>1 mm in length), collected monthly from 25 April to 5 August 1991.

Zooplankton total fatty acid concentrations gradually decreased from 25/4 to 23/7, significantly influencing the total samples concentrations (Tab. 1). Fatty acid composition of the zooplankton caught from 25/4 to 21/6, in addition to the highest fatty acid concentration observed, contained high proportions of PUFA, which partly exceeded or were in the same ranges observed in healthy growing zooplankton (MORRIS, 1971). In this period the microphytoplankton densities, probably the main zooplankton food source, were the highest in the investigate period. Related to this, fatty acid composition indicated diatoms as one of the most important source of sediment trap zooplankton free fraction. Other sources were also microzooplankton and fecal pellets, indicated by domination of shortchain alkanes and PR/C_{17} ratio higher than one. From 21/6 to 23/7 zooplankton fatty acid concentrations decreased, PUFA proportion reached minimal values, and reversal of the PR/C_{17} ratio occurred in zooplankton samples, while in the rest of material the ratio remained above one. These results indicated prevailing of starving conditions for zooplankton. In fact, microphytoplankton densities were significantly reduced in the water compared to the previous periods (Tab. 1). Moreover, in this period large mucilaginous aggregates massively appeared, additionally subtracting food from zooplankton.

The results have shown that fatty acid composition of the sediment trap material significantly depends upon macrozooplankton composition.

It should be claimed out that beside the quantity of the free swimmers in sediment traps, very important factor is the physiological condition of the zooplankton. The need of separated analyses is shown.

Table 1. Fatty acid concentration (c), percentage composition of saturated (sat.), monounsaturated (MUFA) and polyunsaturated fatty acids (PUFA), PR/C_{17} ratio and microphytoplankton fraction density (>20μm, on 20 m depth, mF), in the total (T), zooplankton free (ZF) and zooplankton (Z) samples.

	Sampling intervals	c (mg/g)	Sat.	MUFA	PUFA (%)	PR/C_{17}	mF $10^4/dm^{-3}$
T	25/4-	2.65	41.7	31.8	26.4	4.6	5.1
ZF	14/5	0.81	55.2	30.1	14.2	6.2	
Z		15.31	28.8	32.9	38.3	2.6	
T	14/5-	3.61	46.4	37.5	16.1	5.8	27.5
ZF	21/6	0.59	35.8	42.4	21.7	5.2	
Z		12.19	25.3	28.7	45.9	5.5	
T	21/6-	0.87	78.6	18.4	3.1	1.4	0.81
ZF	8/7	1.16	88.9	9.7	1.3	3.6	
Z		5.14	65.8	28.5	5.7	0.7	
T	8/7-	2.52	49.0	22.0	28.9	1.8	0.66
ZF	23/7	4.63	45.9	36.3	17.8	4.2	
Z		2.29	67.9	26.5	5.6	0.5	
T	23/7-	1.20	35.9	28.9	34.5	1.5	2.50
ZF	5/8	2.63	39.2	32.1	28.6	2.6	
Z		4.81	55.9	28.9	15.1	1.0	

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C

Sorption of Mercury on clay minerals in Chloride media
1. Bentonite

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Mercury is among the most toxic elements in general. Detailed studies of mercury speciation in natural aquatic environments are complicated by the fact that mercury - with its three redox states - forms a rather wide variety of species, both organic and inorganic. The situation is rendered even more complex by the reality that the various ionic and molecular species of mercury have different physico-chemical and toxic properties. Most mercury compounds have low solubilities in natural waters and organic forms accumulate in aquatic organisms (BERNHARD, 1988). The predominant species of dissolved mercury in an oxygenated natural water depend primarily on the pH and chloride concentration of the aquatic environment. This is due to the very stable chloride complexes of divalent mercury, and the stable form of mercury in seawater is the $HgC1_4^{2-}$ anionic complex (BENES and HAVLIK, 1979; STUMM and MORGAN, 1989).

Mercury also shows a pronunced tendency to become adsorbed on solid particles such as suspended material and various sediment matrices. Clay minerals have for a long time been recognized as suitable agents for the removal of toxic elements and other pollutants from aqueous solutions. They show a particular propensity to adsorption of metal ions, and have thus found frequent use as scavengers for heavy metals (including Hg) over a wide range of concentrations. Bentonites, both synthetic and natural, have particularly strong sorption properties with regard to metal ions. This is mainly a consequence of their structure where sheets of SiO_2 tetrahedra are partly substituted with octahedrally coordinated aluminium. In addition, various ionic (both cationic and anionic) substitutions are possible and occur frequently in natural bentonites. There are usually differences in the coordination on the surfaces of sheets and on the edges. This leads to the formation of different reaction sites and, consequently, differing surface potentials (/charge) on the bentonite. A possible effect of this is the interaction of adjacent charge sites and the electrostatic neutralization of surface charge by substituting elements/ions. Characteristic for bentonite are therefore multiple heterogenous sites and multiple functional groups.

In this work, investigations of Hg adsorption and desorption on natural Na- and Ca bentonite in various buffer systems were carried out. The released ions from bentonite in deionized water, the loss of dissolved Hg(II), and the influence of the pH and chloride concentration on the formation of mercury complexes was studied. The Hg contents in solution were determined by cold vapour atomic absorption spectrometry (MAY and STOEPPLER, 1984) using $SnCl_2$ and H_2S0_4 as reducing agent and amalgamation on gold wire. The released ions from bentonite into solution were determined by the use of a modified ion chromatography Dionex system 12 (NGUYEN, 1989). In deionized water, high amounts of cations and anions is released from Na bentonite. High loss of Hg was found from the buffer solution at pH 6 by volatilization into the atmosphere. In the pH range from 3 to 13, dissolved Hg(II) adsorbed well on bentonite as correlated with $Hg(OH)_2$ which are the predominant species in the solution. With the additon of increasing concentration of chloride ions, the uptake of Hg is reduced because of the occurence of chloro-complexes.

Bentonite adsorbed mercury(II) species from the solution at pH 5,00-5,50 with a capacity of 0.32 mol/kg and follows the Langmuir model. Adsorption kinetics of Hg on bentonite depends on the components in solution and on the form of bentonite as well. The results obtained show a low adsorption rate of dissolved Hg(II) on Ca bentonite in buffer pH 8 solution.

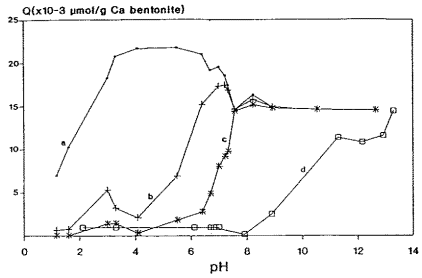

Fig. 1. Effect of pH and chloride concentration on the adsorption of Hg(II) on Ca-bentonite (Niederbayern, Germany: a) deionized water; b) 10^{-3} mol/L NaCl; c) 10^{-2} mol/L NaCl; d) 0.5 mol/L NaCl (0.045×10^{-6} moles Hg(II) and 2 g bentonite equilibrated in 40 ml deionized water for 24 h at 294 K)

Natural calcium bentonite can be used for the elimination of dissolved inorganic mercury from natural waters. In deionized water (pH 5.50), an amount of 60 g Hg(II) can be adsorbed on 1 kg bentonite after 24 hours. The pH value and chloride ions influence the Hg uptake on bentonite. In the pH range from 3 to 13 and a chloride concentration below 10^{-3} mol/L, a high uptake may be observed. With increasing chloride concentration from 10^{-3} to 0.5 mol/L, the amount adsorbed is reduced because of the occurence of chloro-complexes. In addition, chloride salts or hydrochloric acid can be used for extraction of the adsorbed Hg from the bentonite. Hydrochloric acid of 0.1 mol/L extracts about 80% of adsorbed Hg from bentonite.

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Caractérisation des substances humiques de sédiments estuariens récents par la technique de Pyrolyse - CPL - CPG

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Afin de bien élucider la participation de précurseurs d'origine terrestre et/ou marine lors de la formation des substances humiques sédimentaires (SHS) dans les estuaires, nous avons fait appel à la technique de Pyrolyse - Chromatographie en Phase Liquide - Chromatographie en Phase Gazeuse (Pyrolyse - CPL - CPG); d'autres méthodes analytiques plus classiques (analyse élémentaire, spectroscopie d'absorption en infrarouge et spectroscopie de résonnance magnétique nucléaire du ^{13}C) ont eté également utilisées pour acquérir certaines informations complémentaires et indispensables sur la matière humique en question.

L'analyse des substances humiques extraites de sédiments récents de l'estuaire de l'Elorn (France) indique que ces composés, et plus particulièrement les acides humiques, possèdent de nombreuses propriétés communes à leurs homologues lacustres : teneurs relativement élevées en azote et en soufre et faible taux d'aromaticité. Lors de la pyrolyse, des bilans pondéraux des différentes fractions produites, et de celles constituant le pyrolysat sont établis; la distribution des hydrocarbures saturés et insaturés, des iso+cyclo alcanes et des alcènes dans le pyrolysat des acides humiques sédimentaires (AHS) est étudiée et comparée avec celle des AHS de différentes origines. L'étude des hydrocarbures biomarqueurs (distribution et rapports stéranes / hopanes) issus de la pyrolyse des AHS confirme la participation de précurseurs d'origine algaire dans les processus conduisant à la formation des substances étudiées. Ces résultats se confirment pour l'ensemble de la zone estuarienne, quel que soit l'emplacement du site étudié (partie amont, médiane ou aval de l'estuaire).

Effects of weight and age on Cadmium and Lead levels in foot, gills and the rest of soft tissue of Mussel *Mytilus galloprovincialis*

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Natural levels of Cd and Pb in foot, gills and the rest of soft tissue were analyzed in ıussel *Mytilus galloprovincialis*, collected from unpolluted shelf breeding area ıistrina in the Bay of Mali Ston (eastern middle Adriatic). Three different age groups ere used (A, 1.0; B 1.5; C, 2.0 years).

The aim of this study was to establish the distribution of these metals between foot, ills and the rest of soft tissue as affected by the weight and age of organisms.

Cadmium concentration in foot of mussel from the natural environment was ›und to decrease with the increase of this organ mass (Fig. 1).

This was observed for all three ge groups (A, B, C), particularly ›r the youngest one. In contrast › the mass, age does not affect ıdmium concentration in mus- ›l foot.

The effect of foot mass on lead ›ncentration is more significant ıan in Cd (Fig.1). Pb concen- ations is decreased with greater ›ot mass in all age groups, ırticularly in age group A.

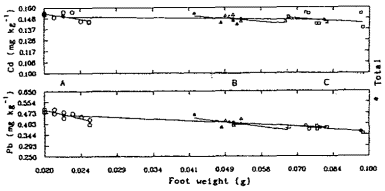

Fig.1. Log-log relation between metal concentration and foot wet weight

Apart from the tissue mass, lead concentration in foot (in contrast to cadmium) is e function of mussel age.

As distinct from foot, Cd ›ncentration in gills is gher if their mass is greater ig. 2). This was observed for l three age groups, ırticularly for the oldest one ') Cd concentration in gills ghtly increases with mussel e.

Gill mass increase effect on › gills concentration is nilar to that on Cd gills ncentration (Fig.2). Lead ncentrations are also gnificantly affected by ıssel age.

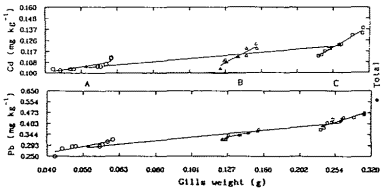

Fig.2. Log-log relation between metal concentration and gills wet weight

In contrast to foot and gills, in hich the mass considerably ects cadmium and lead levels, e rest of soft tissue does not at l affect its Cd and Pb ncentrations (Fig. 3).

Cd concentration is very ghtly reduced and that of lead ry slightly increased with ıssel age.

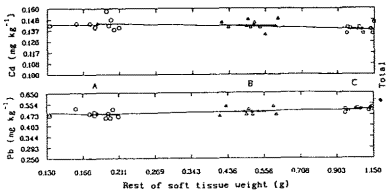

Fig.3. Log-log relation between metal concentration and the rest of soft tissue weight

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Mercury and Chromium in organisms of the coastal marine area between Po Delta and Ravenna Harbour

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Samples of marine sediments and organisms were collected in March 1990 from the coastal area of the Northern Adriatic Sea between Po River Delta and Ravenna Harbour (Fig. 1). In this area, influenced by Po River waters (BARALE *et al.*, 1986), a high deposition of fine materials takes place at a depth higher than 10 m, especially in winter (BORTOLUZZI *et al.*, 1984). Dredging materials from Ravenna Harbour are disposed in a rectangular dumping site (Fig. 1).

Table 1 shows the Hg and Cr contents in the superficial sediments of the studied area (GIANI *et al.*, 1992). Hg and Cr decrease from delta Po southwards. The maximum Hg concentration is in the harbour zone due to general pollution of the channel harbour and surrounded salt marshes caused by chemical plants (MISEROCCHI *et al.*, 1990).

The organisms collected were classified, weighed and their length measured. Muscle tissue of specimens of *Gobius niger jozo* (n=10), *Squilla mantis* (n=7) and soft tissue pools (1-8) of specimens of *Ostrea edulis* (n=17), *Crassostrea gigas* (n=45) and *Natica millepunctata* (n=8) caught in the different zones were digested in teflon bombs with nitric acid by a microwave digester. Hg was determined by CVAAS after reduction by SnC12 and Cr analysis was performed by GFAAS (Fig. 1 and Fig. 2). The recoveries with respect to MA-A-2 (TM) reference material were 100% for total Hg and 88% for total Cr.

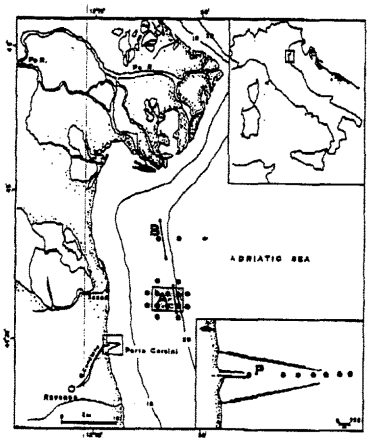

Fig. 1 - Study area and sampling stations (A : dumping-zone; B : Po-delta-zone; P : harbour-zone; O : sediments; -> : organisms).

Mercury. Hg values are low. There are no differences between the Hg levels in the same species caught in the different zones. *S. Mantis* and *C. gigas* seemed to be the better Hg-concentrating species. In *G. niger jozo* Hg increases with the total length but the values are five-fold lower than those reported by other authors for the same area and about *S. mantis* and *N. millepunctata* our data are lower than the ones too (CIUSA and GIACCIO, 1984). In *O. edulis* and *C. gigas* Hg concentrations are generally lower than the ones found in the Venezia Lagoon (PERDICARO, 1989). Chromium. The Cr letterature data are often not sufficient and not comparable. Fig. 1 shows higher Cr concentration in the bivalves and a gradual decrease from the specimens of the A-zone towards B and P-zone. This observation and the apparent Cr concentration decrease with the toal length of the *S. mantis* need further research.

TABLE 1 - Hg and Cr concentrations (µg/g d.w.) in surface sediments.

Zone	N° of samples	Hg Range	Hg Av. ± S.D.	Cr Range	Cr Av. ± S.D.
A	14	0.130-0.460	0.278 ± 0.102	123-162	135 ± 14
B	2	0.380-0.508	0.444 ± 0.064	161-171	166 ± 5
C	6	0.120-1.932	0.607 ± 0.653	92-124	113 ± 15

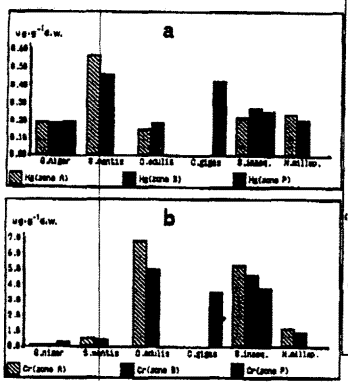

Fig. 2 - Hg average concentration (a) and Cr average concentration (b) in some species caught in the different zones.

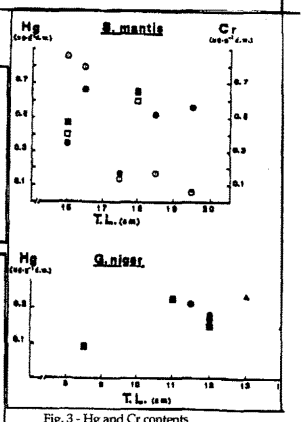

Fig. 3 - Hg and Cr contents versus Total Length (T.L.).
Zone A: Hg ( ) and Cr ( ).
Zone B: Hg ( ) and Cr ( ).
Zone P: Hg ( ).

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Observations carried out between 1988 and 1991 on the state of the water of the Marche Coast

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Between 1938 and 1991 a series of chemical, physical and biological tests were carried out on the water along the Marche Coast (PENNA *et al.*, 1989). This was in order to acquire better knowledge of the trophic state of the water and of the algae blooms that periodically appear in this area of the Adriatic Sea.

The conclusions that can be drawn are in agreement with the fact that in the years taken into consideration there have been no significant eutrophic phenomena in the water of the Central-Northern Adriatic and consequently there has been no algae flowering. The last significant episode was in 1984.

Instead, notable observations on other algae pollution phenomena have been found during the last few years (DEGOBBIS, 1989).

Above all, there has been the appearance of extracellular material or "mare sporco", as it was called in the past (HERNDL et PEDUZZI, 1988 a).

These phenomena appeared in August 1988, in July-August 1989 and in June-September 1991. During the appearance of the mucilages, tests were carried out on the dissolved oxygen along the water column of the area involved. On the basis of these tests, hypoxic and anoxic phenomena of the water can be excluted in all periods in which extracellular material appeared on the water surface.

Possible death of benthonic organisms such as MEL was due to forms of mechanical suffocation following accumulation of mucilaginous masses on the sea bed.

In 1988-89 the mucilages moved "en masse" to the upper part of the Adriatic where more consistent formation seemed to take place and to the South in Emilia, Marche and Abruzzo (RINALDI *et al.*, 1990). The reason for this was the North-South current that affect the Western coasts of the Adriatic (Fig. 1).

In 1991 the appearance of extracellular material followed a different pattern compared with previous years, both as regards the place of their formation and their diffusion. The mucilages appeared almost simultaneously in the entire Adriatic from Istria to Ancona, but in a much smaller quantity.

Along the Marche coast there was no great surface movement caused by North-South currents, contrary to what happened in 1988 and 1989.

In 1991 the formation of mucilaginous masses seemed to be of local origin and for this reason was in a much smaller quantity than in previous years.

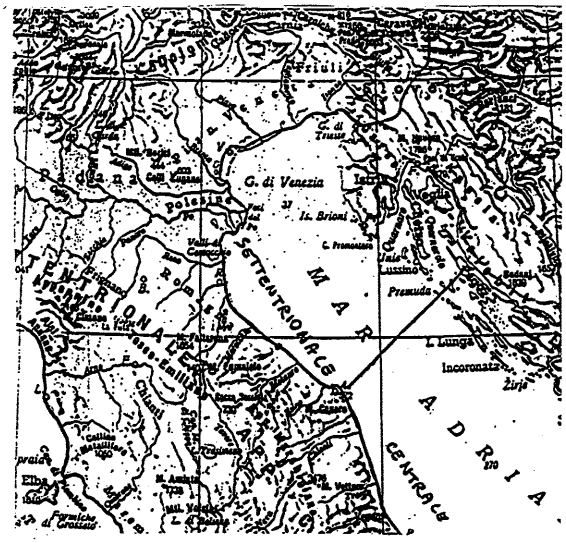

Fig. 1.

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Exploring the ecological consequences of the sinking of LGC B. Montanari : Fouling on the Wreck

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In November 21984 Italian liquid gas carrier (LGC) "Brigitta Montanari" with mor than 1300 tons of vinyl chloride monomer (VCM) sank in the middle Adriatic Sea a the depth of 82 m. Rudjer Boskovic Institute, Zagreb, Croatia, supervised houling ou the wreck and recovering the cargo. The salvage operation started in autumn 1985, bu due to an accident it was stopped. Action was renewed in 1987 and successfull finished in spring 1988. More than 700 tons of VCM was recovered from the wreck bu the rest was released to the environment.

Rudjer Boskovic Institute project "Exploring the Ecological Consequences of Sinkin of LGC B.M." included the research of fouling on the wreck. Due to the fact that th fouling organisms were in the longest contact with the VCM leaking from the wrec (from the moment of larvae attachment till the hauling the wreck out), they can b one of the best indicators of toxic effects of VCM.

The fouling samples were taken on the 24th and 25th of June, 1988, during the la stage of the houling, immediately after the wreck appeared on the water surface.

Qualitative samples were taken from the stern, low, portside, starboard, ropes, an quantitative sample was taken from the left side of the bow.

Fouling developed on the wreck that had rested at the depth of 82 m for 3 years wa similar to the natural fouling of the circalitoral of the middle Adriatic. The element of the biocenosis "coraligen of lower horizon of littoral zone", the biocenosi "community of open-sea underwater rocks" and the elements of biocenosi "community of detritical bottom of the open inland area" on spots with settle sediment were found.

Decks, deck gears, masts, davits, stays, rescue boats, funnel, stern and portside of th bow were heavily overgrown. Less fouling was observed on starboard and starboar upperdeck, and there was almost no fouling on the hull below the water line, at th front side of the commanding bridge and a part of the portside. Fouling was la developed at the surfaces which were in vertical positions (surfaces with no sedimer on them). Surfaces with some sediment were less overgrown and there were n fouling organisms on the parts which were lying on the seafloor. Besides exposition t sedimentation it is possible that chemical components of paints used on the ship als influenced the larvae attachment and growth.

Quantitative sample taken from 1 m^2 of the portside weighed 7765 g and tot weight of fouling on the wreck was estimated at 10 tons.

Although more than 30 species were found the most abundant organism wa *Pygnodonta cochlear* (Poli) (over 95% of biomass). Macroscopical analysis of a organisms showed no sign of either acute or chronical toxic effects of VCM.

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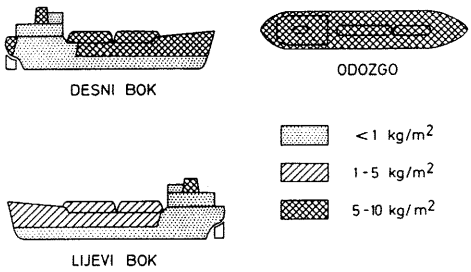

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The influence of surface active substances on metal ions (Cd,Cu,Pb,In and Tl) speciation in NaCl solutions

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The speciation of metal ions in natural waters is governed by the presence of inorganic and organic ligands as well as particulate matter (BRULAND, 1983). A part of organic matter with surface active properties is very important as it influences the distribution between heavy metal species in the bulk of solution as well as their fractionation at different phase boundaries (COSOVIC, 1990).

Electrochemical methods (differential pulse voltammetry and alternating current voltammetry in phase and out of phase) were used to study adsorption processes at the electrode/solution interface as well as complexation in the solution.

General scheme of the applied methodology is presented in Fig.1. For studying reduction processes the electrode is pretreated at the potential more positive than the standard redox potential by formation of the adsorbed layer of organic molecules.After the absorption period the reduction process of metal ion is measured at the modified electrode surface during the scan in negative direction. For studying oxidation processes the electrode is kept at the potential more negative than standard redox potential while simultaneously adsorption of organic molecules and reduction of metal ions occur. After the accumulation time period the reoxidation of metal is measured during the potential scan in positive direction. However this process takes place at the electrode which is modified by the adsorbed layer of organic molecules.

The comparison is made between the influence of humic acid(HA) and nonionic surfactant Triton-X-100 on the cathodic and/or anodic waves (PLAVSIC and COSOVIC, 1991; PLAVSIC *et al.*, 1991) of heavy metal ions (Cu,Cd,Pb,In and Tl). Triton-X-100 is a typical neutral nonionic surface active substance which absorbs strongly at the mercury electrode and affects charge transfer processes at the electrode/electrolyte interface. HA is at the same time surface active and complexing agent.The complexing capacities of HA for Cu,Cd,Pb,In and Tl were measured in the bulk of solution by direct titration with heavy metal ion (PLAVSIC *et al.*, 1982).

At lower pH values (pH=1.6) the cathodic and anodic waves of metal ions (Cd,Pb,In) decrease with increasing the amount of SAS (both HA and Triton-X-100) and follow the adsorption isotherm of the particular SAS. The same behaviour was also observed for Triton-X-100 at higher pH values (pH=6.4). At higher pH values the predominant reaction of Cd, Pb and In with HA will be complexation reaction, usually enhanched at the electrode surface due to the higher amount of HA present in the interfacial region.

The hydrophobic/hydrophilic effects and dehidratation step of aqua complexes of metal ion play an important role in the interfacial region especially for indium ions.

For Cu the predominant reaction with HA will be complexation even at low pH values (pH=1.6) Tl^+ions are not influenced by the presence of SAS due to a small size and a low tendency for forming complexes .

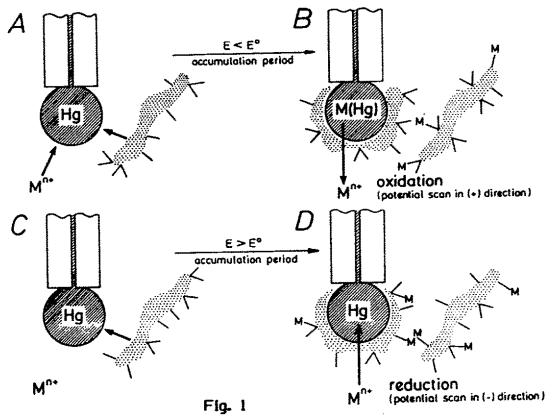

Fig. 1

Our experiments demonstrated that by relatively simple electrochemical method, following the influence of different organic substances on the oxido-reduction processes of different heavy metal ions and adsorption properties of natural and synthetic organic matter some conclusions regarding heavy metal ion speciation (preference for complexation in the bulk of solution, enrichment on the phase boundaries) as well as the nature of the organic matter (adsorbability at the electrode, interaction in the bulk of solution, preference for certain metal ion) can be drown. The results obtained can be applied to the natural water systems.

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Nutrient enrichment and deep chlorophyll maximum along the Algerian current.

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The *Médiprod VI* cruise was performed in June 1990 to obtain hydrological, chemical and biological data in the Algerian current between 1°E and 5°E with a high space resolution. The main objective was to understand what dynamical processes bring nutrients in the euphotic zone and explain the high values of chlorophyll concentrations encountered near the basis of the photic zone.

From an hydrological point of view, the surface waters are characterized by two different water bodies separated by a strong salinity gradient: near the coast was de Modified Atlantic Water (MAW) with salinities lower than 36.60 and, at about 60 km off the coast, the Surface Mediterranean Waters (SMW) with salinities ranging from 36.80 to 36.90. The boundary of the "Atlantic jet" appears to be the 36.60 isohaline.

Main features of the nutrient field (nitrate) (fig. 1) are:

1/ below the nitracline, the vertical nitrate distribution shows a tongue-like distribution with superposition of minima and maxima.

2/ the presence near the coast of a relatively nitrate-rich water (4-5 µM) of deeper origin along the 27.5 isopycne and of a nitrate-poor layer (< 3 µM) along the 27.5 isopycne, associated to high levels of dissolved oxygen (> 5.0 $ml.l^{-1}$) and to chlorophyll concentrations greater than 0.2 $mg.m^3$, showing its subsurface origin.

3/ in the offshore area, it can be noted successively the presence of a nitrate-rich layer (> 5 µM) crossing the isopycnes and of a nitrate-poor layer (< 3 µM) which do not follow an isopycnal level.

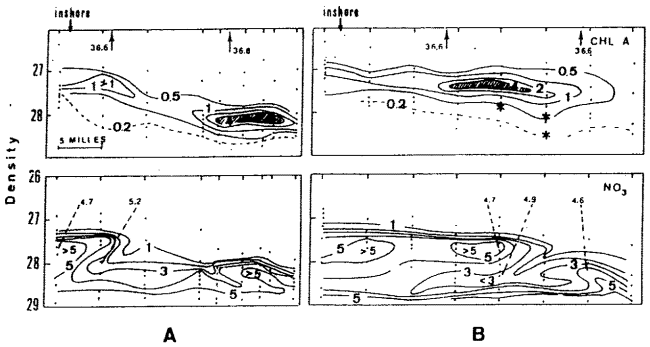

Figure 1: *Chlorophyll and nitrate concentrations along the 1°10' E transect (A) and the 3°10' E transect (B). Chlorophyll concentrations greater than 4 $mg.m^3$ have been shaded. Some oxygen values ($ml.l^{-1}$) are reported on the nitrate diagrams.*

The surface chlorophyll concentrations are less than 0.10 $mg.m^3$ over the whole area. Higher concentrations from 2 to more than 15 $mg.m^3$ occured as a Deep Chlorophyll Maximum (DCM) in a narrow band between 15 to 30 miles off the coast line. This DCM has a width of 10 to 15 meters at a depth of 50-65 meters; it is associated with nitrate concentrations higher than 1 µM and with low ligth intensity (1 to 3% of the surface irradiance). On each side of the narrow band with high chlorophyll values the DCM is characterized by concentrations ranging from 0.5 to 1 $mg.m^3$ and a sharp gradient.

DCM was correlated to density values of 28.0-28.1 on the western part of the studied area while eastward it was associated to densities of 27.4.

DCM was always located just above the sharp nitrate gradient associated to intrusions of nitrate-rich waters.

These observations can be explained by nutrient inputs into the photic zone resulting of the cross-frontal circulation: 1/ on the inshore side of the current the nutrient enrichment would originate in isopycnal vertical motions as proposed by YENTSCH (1974), FASHAM *et al.* (1985), PRIEUR (1986) and BOUCHER *et al.* (1987); 2/ on the offshore side, the nutrient intrusion would be due to diapycnal mixing according to the scheme proposed by TANG (1983).

Thus the DCM in this area can be explained as resulting of an equilibrium between nutrient fluxes, light availibility and water stability.

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Intercalibration activities in the frame of the complex monitoring Program of the Adriatic Sea (ASCOP)

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ASCOP is a multidisciplinary joint program which incorporates numerous physical, chemical, geological and biological parameters in monitoring of the Adriatic Sea. The aim of the program is to assess physical, chemical, sedimentological and biological characteristics of this marine environment as well the effects of pollution to the Adriatic Sea.

On the Croatian side three marine Institutes participate in the realization of this program, while on the Italian side several Institutes are involved. Sampling and the measurements within the ASCOP program refer until now to the international waters of the North and Middle Adriatic Sea.

Due to the fact that data on various parameters are collected at ASCOP cruises by different participating laboratories it is of primary importance to define how reliable these data are. In order to determine whether the results of the measurement are reliable or not, the performance of the individual laboratories should be evaluated by their participation in the intercalibration. Only analytically sound and reliable data can serve as the basis for comparison of the parameters as well as for drawing out the conclusions on certain processes occuring in the Adriatic Sea. Estimated accuracy and precision of measurement of the participating laboratories should be a fundamental part of the monitoring program and mandatory to the participating laboratories. Quality control of the measurement process should become a general practice for the participating laboratories being involved in the ASCOP.

In 1986 the program of intercalibration in the frame of ASCOP has been defined. It has been forseen that the intercalibration activities should proceed in several steps with the purpose to identify possible sources of errors and to reduce the degree of non-reliability of the results of the same parameter measured by different laboratories as well within each individual laboratory.

Laboratory intercalibration in the frame of ASCOP, which is the subject of this presentation, proceeds in two steps:

a) calibration of the measuring instrument(s) and/or the accuracy of the analyst. Calibration is performed with the standard reference material for which the amount of the measured component is known to the analyst;
b) measuring the standard reference material for which the amount of the measured component in the sample is not known to the analyst. Methodology applied corresponds to the one usually applied for the monitoring purposes. Concentration level of the measured component(s) and the composition of the standard reference sample should mimic those of the samples from the marine environment (seawater, biota, sediments), which are collected during monitoring cruises.

Laboratory intercalibration excercise which took place during 1988 and 1989 for certain selected parameters proceeded in steps a) and b).

Calibration of the instrument and the accuracy of the analyst was tested on the parameters chlorofil a and nutrient salts with the standard reference material from Environmental Protection Agency (US EPA), Ohio, USA.

The reliability of the applied analytical method according to step b) was evaluated at two concentration levels with the Sagami standard reference material (SRM) for nutrients in seawater. Methodology for the determination of the content of trace heavy metals (Pb, Cu, Zn) in the sediment was evaluated with the SRM from US NIST (previous US NBS).

Achievements and problems appearing during laboratory intercalibration excercise will be discussed. Main problems are the following:

- Each parameter in the frame of the monitoring program should be documented with respect to sampling, sample storage, sample treatment and the analysis, which is applied by the participating laboratories for the realization of the monitoring program. The described protocol should be obeyed during the monitoring program as well as during the intercalibration. All possible changes of the protocol should be documented and verified with respect to the improvement achieved.

- It is further on necessary to elaborate in more extensive manner the SRM, which will be representative of the Mediterranean and additionally of the Adriatic marine environment. Representative SRM are crucial in obtaining reliable information on the consistency of the validated methodology.

- Beforehand, the overall policy of the monitoring program should include a defined attitude toward the laboratories avoiding to participate in the intercalibration activity.

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Chemical and instrumental Neutron Activation Analysis of Bed sediments sampled on Danube River, during 1991

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Abstract

Bed-load sediments sampled on the both Danube river sides in front of the Nuclear Power Plant at Koslodui, by chemical and instrumental neutron activation analysis were investigated. The Cr ranged between (74 : 128) ppm, Zn(37 : 78)ppm, Ba (201 : 327) ppm, U (l,l : 2,9) ppm.

From a radioecological point of view the study of stable elements in natural systems such rivers and seas is important since radioisotope introduced into the water follow similar pathways to the stable elements already present in nature. It is well known that the chemical composition of the river bed sediments has a great influence on the retention and the exchange of man-made radionuclides between crystalline lattice and the soluble form of the radionuclide in water (GEORGESCU *et al.*, 1973 and 1981).

The sampling was carried out with simultaneously hydraulic measurements on significant verticals according to the methodology applied by the National Institute of Meteorology and Hydrology in Bucharest. Each wet sample of about 1 kg was stored in plastic bags. The chemical analyses were effected as described by GEORGESCU and STROILA (1981). The instrumental neutron activation analyses were carried out at the VVRS nuclear reactor in Bucharest. The counting was made by means of HPGe crystal coupled to a multichannel analyzer.

In the Table 1 are listed contents of ten macroelements, in Table 2 of 24 macro- and microelements, The last column of Table 1 shows that the loss of weight at 1000°C in percent is low for organic matter. It must be outlined, an increasing of Fe, Ca, Ti ,Mg Mn, Na, K. The sediments of left river side have more As, Br, Cr, Th, U and Zn. Barium has a concentration of 327 ppm on the right and 201 ppm, on the left river side. Si and Al are about constant, while phosphorous is decreasing. These changes in the concentration of the microelements are correlated with the grain size diameter of the sediment, the velocity flow on the bed river, the surface and average velocity and turbidity.

It is a decrease of phosphorous and an increase of some toxic microelements in the investigated Danube sediments.

Cross-section and date of prelevation	Element										Loss of weight at 1000°C(%)
	Si	Fe	Al	Ti	Mn	Ca	Mg	P	Na	K	
Upstream Bechet right* 17.06.1991	38.4	2.2	1.5	0.1	0.1	3.2	1.3	0.03	0.8	1.0	2.5
Downstream Bechet right 18.06.1991	32.0	3.6	2.2	0.07	0.07	5.02	1.9	0.04	2.06	1.8	6.6
Turnu Magure le - left 19.06.1991	38.9	3.6	0.6	0.06	0.08	2.3	0.6	0.03	0.7	0.6	3.9

Table 1- Chemical composition of the sediments collected on the bottom of the Danube river, in percent dry weight.

Sample / Elem.	River side		Sample / Elem.	River side	
	left	right		left	right
As(ppm)	8.9 ± 0.3	6.2 ± 0.2	Lu(ppb)	84 ± 5	34 ± 3
Br(ppm)	3.7 ± 0.5	1.8 ± 0,5	Na(%)	1.38± 0.01	1.20± 0.01
Ba(ppm)	201 ± 40	327 ± 14	Nd(ppm)	26 ± 6	< 17
Ca(%)	0.40± 0.01	0.10± 0.01	Rb(ppm)	48 ± 22	27 ± 16
Ce(ppm)	60 ± 2	14 ± 1	Sb(ppm)	1.2 ± 0.1	0.60± 0.05
Co(ppm)	9.2 ± 0.8	7.0 ± 0.7	Sc(ppm)	8.2 ± 0.1	2.80± 0.06
Cr(ppm)	128 ± 4	74 ± 3	Sm(ppm)	4.9 ± 0.1	1.3 ± 0.1
Cs(ppm)	2.3 ± 0.4	0.6 ± 0.3	Tb(ppm)	0.50± 0.2	0.5 ± 0.2
Fe(%)	2.31± 0.07	1.10± 0.04	Th(ppm)	7.2 ± 0.4	1.5 ± 0.2
Hf(ppm)	6.2 ± 0.3	1.2 ± 0.1	U (ppm)	2.9 ± 0.3	1.1 ± 0.2
K (%)	1.09± 0.07	0.90± 0,07	W (ppm)	1.2 ± 0.4	0.7 ± 0.3
La(ppm)	26.5± 0,3	6.9 ± 0.1	Zn(ppm)	78 ± 19	37 ± 15

Table 2 - Microelements identified in the bed-load sediments of Danube river in front of Bechet site in June 1991 (long-lived radionuclides)

* right - the right river side; left - the left river side.

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INAA of trace elements in marine sediment (SD-M-2/TM, Reference Material)

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Abstract

Determination by instrumental neutron activation analysis method of concentration of 41 elements in Mediterranean deep-sea sediment as "total" sample analysis as well as of 24 elements in partial digested sample has been performed.

Introduction

Trace elements analysis of marine sediments is an important problem from geochemical and environmental pollution studies point a view. This paper represent our contribution to the intercomparison run organized by the Marine Environment Laboratory of IAEA on trace element measurements of deep-sea sediment, as reference material, 121 laboratories from 51 countries have participated in this exercise and reported results for 62 elements, this intercomparison appears to be the widest one. The sediment sample was collected in July 1987 in the Mediterranean sea at a depth of 1240 meters.

Experimental

The samples and standards have been irradiated for long and short time in VVR-S reactor at 10^{11} - $3 \cdot 10^{12} n \cdot cm^{-2} s^{-1}$ flux. The measurements of gamma spectra have been made using a high resolution HPGe detector connected to the multichannel analyzer. Besides the "total" sample investigation, the analysis of simple partial extraction with IM hydrochloric acid has been performed in order to evaluate the effectiveness of different procedures for sample digestion.

Results and discussion

Our concentration values representing the arithmetic means of three separate determinations with the corresponding standard deviations are shown in Tables 1, 2 for total sample analysis (41 elements) and in Tables 3, 4 for partial digested sample (24 elements). A very hard and careful analysis for so many elements has been carried out in our laboratory. It is therefore a great satisfaction to have now the opportunity to pointed out the good or very good quality of our results on this valuable and convenient reference material for the future analyses.

Table 2.- Noncertified values of elemental concentrations in the marine sediment (SD-M-2/TM, reference material)

Element	Range of submitted means	Our values	Number of participated laborat.
Au (ppb)	6 - 110	6 ± 2	2
Cl (%)	1.560 - 1.566	1.566 ± 0.026	2
Dy (ppm)	1.68 - 3.83	2.97 ± 0.21	4
I (ppm)	34.7 - 77.0	34.7 ± 2.1	2
In (ppm)	0.133 - 69.50	0.133 ± 0.025	2
Mo (ppm)	2.70 - 3.43	3.43 ± 0.06	2
W (ppm)	1.7 - 2.4	2.4 ± 0.1	2

Table 3.- Elemental concentrations in partial digested marine sediment (SD-M-2/TM/P)

Element	Concentration	Confidence interval	Range of accepted results	Our values
Al (%)	0.32	0.204 - 0.408	0.18 - 0.56	0.344 ± 0.036
Ba (ppm)	35.9	27.3 - 41.7	27.3 - 41.7	37 ± 8
Ca (%)	12.3	10.6 - 13.9	10.6 - 13.9	13.9 ± 0.6
Co (ppm)	7.10	6.36 - 8.57	3.75 - 18.9	8.57 ± 0.64
Cr (ppm)	9.92	9.10 - 12.0	2.95 - 26.07	9.17 ± 0.46
Eu (ppm)	0.365	-	0.27 - 0.57	0.57 ± 0.06
Fe (%)	0.5136	0.430 - 0.618	0.085- 1.210	0.705 ± 0.041
K (%)	0.1565	-	0.1384- 0.1655	0.1655 ± 0.0119
La (ppm)	5.95	2.90 - 10.30	2.90 - 10.30	6.4 ± 0.5
Mn (ppm)	1003	960 - 1040	582 - 1430	946 ± 161
Na (%)	1.03	1.00 - 1.09	1.00 - 1.09	1.05 ± 0.02
Rb (ppm)	7.05	-	2.4 - 9.6	5.8 ± 0.5
Sb (ppb)	170	80 - 400	80 - 400	80 ± 3
Sr (ppm)	490	440 - 525	435 - 586	493 ± 9
V (ppm)	15.70	13.8 - 18.6	12.0 - 22.3	13.3 ± 2.3
Zn (ppm)	25.0	23.4 - 30.3	4.6 - 55.5	22.0 ± 4.4

Table 4.- Range of elemental concentrations in partial digested marine sediment (SD-M-2/TM/P)

Element	Range of submitted lab. means	Our values	Number of participated laboratories
Ce (ppm)	5.6 - 36.3	16.3 ± 1.3	5
Lu (ppm)	0.03 - 0.08	0.08 ± 0.01	3
Sc (ppm)	0.48 - 1.39	0.87 ± 0.03	6
Sm (ppm)	1.0 - 2.2	2.2 ± 0.2	4
Tb (ppm)	0.19 - 0.36	0.23 ± 0.02	3
Th (ppm)	0.23 - 0.42	0.42 ± 0.05	3
Yb (ppm)	0.35 - 0.74	0.74 ± 0.09	4
Zr (ppm)	-	27.7 ± 3.2	1

Heavy metals in seawater and surface sediments of the Gulf of Bourgas

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The Gulf of Bourgas is one of the highly polluted regions of the Black sea coasts. The pollutants includes petroleum products as well as heavy metals. The pollution is due to the geomorphological characteristics of the gulf as well as the presence of a large number of chemical industries in the vicinity of the sea. The investigations on the heavy metal present in the sea-water and the surface sediment is rather scarce. Therefore such a study is very interesting from the analytical as well as ecological viewpoint.

In May and September 1991, an average sample was done simultaneously from the sea water and the surface sediment at three different stations : namely Bourgas Port (I), Petroleum Port (II) and the bulk of the gulf (III). The samples were analysed by suitable electroanalytical methods.

The sediments were collected from the surface by a conventional apparatus, dried at a temperature of 105°C, grinded and fractioned. The preweighed dry sample (d < 0.06 mm) was dissolved in HCl (2:1) on heating, filtered out and analysed by polarographic method with standard deviation [1]. The completeness of the extraction process was controlled by the atomic emission spectral analysis of the insoluble residue.

The Pb content was determined directly in the filtrate. A part of the solution was evaporated to complete drying, then dissolved in excess NH_3 and filtered again. Cu, Zn and Cd contents were determined simultaneously by the polarographic method.

The samples from the sea water was collected in plastic bottles pretreated with HNO_3 and filtered through a membrane filter (pore-diameter < 0.45 μ). With a view to eliminate the organic impurities, the samples were subjected to electrochemical anodic oxidation at +1.4 V for 10 min in a graphite container.

The mentioned heavy metals in the sea-water were determined by a method of anodic stripping voltametry (ASV) [2] under the following conditions: stripping process on HMDE at 1.2V vs SCE for 10 min, deoxidation with N_2 and anodic dissolution of the deposited impurities at a rate of 400 mV/min. The metals under investigation show well-defined sigle peaks and their concentrations were determined by a method of standard addition.

Table 1

Heavy metals in sea-water (sw), μg/l and sediments (sed) μg/g dw

Station		Cu		Zn		Cd		Pb	
		V	IX	V	IX	V	IX	V	IX
I	sw	10.3	11.2	9.3	9.9	0.25	0.23	0.05	0.05
	sed	93.4	99.9	52.4	53.3	3.70	3.90	73.40	78.80
II	sw	15.1	16.8	10.4	10.5	0.28	0.30	0.06	0.07
	sed	115.2	107.6	53.3	61.4	4.80	4.70	79.50	78.10
III	sw	8.7	9.1	10.1	12.0	0.21	0.23	0.04	0.07
	sed	82.2	82.1	50.8	52.2	3.60	3.70	70.40	73.30

The experimental results show that the concentrations of Cu and Cd at station II are the highest - a fact most probably attributed to the presence of Copper mine nearby. The Pb concentrations is comparatively higher at the stations I & II, however Zn concentration is almost constant. Although no general conclutions can be drawn for the seasonal changes in the heavy metal contents, it may be noted that in September, their concentrations are higher. There exist some correlation between the heavy metal contents in the sediments and that in the corresponding sea-water.

The electrochemical methods proposed for the analysis of Cu, Cd, Pb & Zn are rapid, sensitive and selective. Relative standard deviation for the polarographic determination is 2-5 % and that for ASV is 8-12 % (n =6).

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C

Behaviour of Linear Alkylbenzene Sulphonates in the Krka River Estuary

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Despite the numerous investigations of the occurrence, behaviour and fate of linear alkylbenzene sulphonates (LAS) in the wastewater treatment and natural waters (1), reports on these surfactants in marine and estuarine environments are relatively scarce (2, 3).

In order to determine input and distribution of aromatic surfactants in the Krka River Estuary, grab samples of wastewater and estuarine water were taken in the Sibenik Harbour at different distances from the wastewater outlets during 1990-1991. In addition, samples on the vertical profile of the water column were collected by scuba diving.

Quantitative determination of LAS was performed using reversed-phase high-performance liquid chromatography (HPLC) with spectrofluorimetric detection (230/290 nm). Prior HPLC analysis the samples were filtered through glass fiber (GF/F) filters. Dissolved LAS from the filtrate was extracted on C_{18} cartridges (3) while LAS adsorbed on the particles was extracted in methanol using an ultrasonic method.

The concentrations of LAS determined in the wastewater were in the range from 285-1039 µg/L. Dispersion of LAS into the Sibenik Harbour after the wastewater discharge was very fast (Fig. 1). Apparently, after a distance of only 100 m from the sewage outlet further concentration decrease was very slow. Two concurrent physico-chemical processes were thought to be responsible for such behaviour: dilution and fast sedimentation with sewage derived particles. This supposition was well supported by rather high percentage of the adsorbed LAS in the examined wastewaters (from 11 to 59 %). Moreover, selective partitioning of the individual LAS homologues between liquid and solid phase was noticed with the higher homologues (C_{12}, C_{13}) being significantly enriched in the particulate phase.

Distribution of the LAS obtained on the vertical profile of the water column (Fig. 1) can be interpreted as a consequence of strongly pronounced stratification in the Krka River Estuary. The wastewater plume spreads into the Sibenik Harbour almost exclusively in the freshwater layer while the saline layer remains hardly affected. Maximal concentration of LAS was determined in the surface microlayer (24.0 µg/L) but a smaller maximum was also observed at the boundary of the freshwater and salinewater layers. The concentrations of LAS in the underlying salinewater layer were very low (<2 µg/L) indicating that its vertical transport was greatly reduced by the freshwater-salinewater boundary.

An assessment of the LAS input via wastewaters and its quantity present in the water column of the Sibenik Harbour indicated significant losses due to the elimination processes, most probably by biodegradation and/or fast settling of sewage derived particles containing high concentrations of LAS (up to 2245 mg/kg). It was shown by the laboratory simulated biodegradation experiments that the biodegradation half-life of LAS was in the range from 2.8 to >38 days depending on the origin of the bacterial culture (freshwater or salinewater layer) and temperature (4). Significantly slower biodegradation was observed in the salinewater layer compared to the freshwater layer, especially under the winter temperature conditions (Tab. 1).

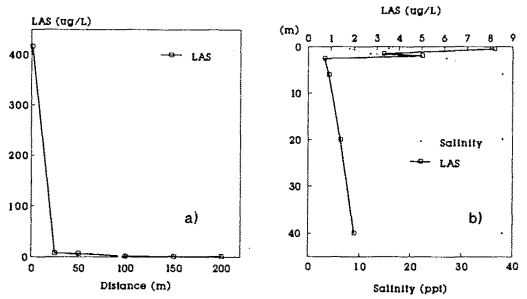

Figure 1. Distribution of LAS in the Krka River Estuary:
a) spatial distribution in the freshwater layer of the Sibenik Harbour correlated with the distance from the major wastewater outlet;
b) vertical concentration profile at the station E4A.

Table 1. The main kinetic parameters of primary biodegradation of linear alkylbenzenesulphonates (LAS) by two mixed bacterial culturesa from the Krka River Estuary.

culture origin	T (°C)	lag-phase (days)	k ($days^{-1}$)	$t_{1/2}$ (days)
E_4A-0.5 m	14	2	0.161	4.3
E_4A-6 m	14	>38	-	>38
E_4A-0.5 m	23	0	0.247	2.8
E_4A-6 m	23	0	0.156	4.4

[a] E_4A-0.5 m = freshwater layer of the estuary
E_4A-6 m = salinewater layer of the estuary

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Distribution of nutrients in the Eastern Adriatic coastal sea - Post Algal Bloom -

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This paper describes the distribution of nutrients (phosphate, nitrate, nitrite, ammonium and silicate) in water samples from 20 sampling stations on the eastern Adriatic coast (Figure 1) collected during August 1989 (post non-seasonal algal bloom).

During summer 1989, like in 1988, large quantities of organic substances and mucouse aggregations were recorded along the coast of northern and middle Adriatic. Vertical stratification of sea water was nominated as a principal cause of bloom. The low horizontal movement retained nutrients in the area that extends from the Po Delta, and the nutrients could not be exported and remained to be biologically used and recycled (DEGOBBIS, 1989).

Due to basic hydrographic parameters during the summer 1989, pronounced stratification of water column occurred in the study area along with the minimum horizontal current. Less saline water in the surface layer was flowing out of the Adriatic and intermediate water of the Mediterranean origin was flowing in to replace that surface water (BULJAN *et al.*).

During this period (August 1989) values of salinity exceeded 38.50 in the bottom layer of the northern Adriatic. Changes of ecological conditions such as migration of some marine organisms from the middle Adriatic (net zooplankton and copepods) were found in the northern Adriatic in this period.

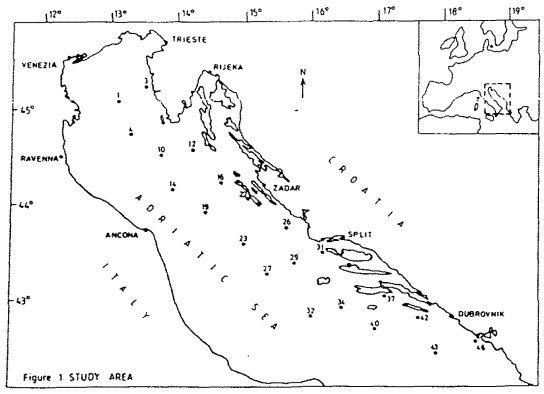
Values of nutrients, except nitrate, were very poor (Table 1) throughout the area in this period due to prevailing processes of assimilation with consumption of nutrients by phytoplankton.

Considerable quantities of nitrate were recorded throughout the area even an order of magnitude higher than the "normal" values. This nitrate enrichment could be attributed to process of regeneration of these salts from organic matter and degradation of large quantities of organic matter mucouse aggregations by bacterial activity. This effect can be confirmed by very high bacterial biomass throughout the investigated area.

Cycles of nutrients in the eastern Adriatic Sea are defined not only by oceanographic and meteorological factors but to a considerable extent, by biological cycles of the organic matter in the sea.

Table 1. Means concentration of nutrients in mmol m^{-3} on investigated area

PARAMETER / STATIONS	NO_3 - N	NO_2 - N	NH_3 - N	PO_4 - P	SiO_3 - Si	O_2	pH
S - 1	3.98	0.118	1.58	0.068	2.74	5.20	8.14
S - 3	3.89	0.096	1.31	0.067	0.47	5.64	8.14
S - 4	5.62	0.162	0.75	0.048	1.70	4.84	8.17
S - 6	5.80	0.155	1.30	0.051	2.58	4.66	8.15
S - 10	3.12	0.158	0.73	0.055	0.98	4.86	8.19
S - 12	3.26	0.105	0.94	0.044	0.17	5.21	8.20
S - 14	4.37	0.085	0.95	0.051	0.59	5.00	8.20
S - 16	5.37	0.105	1.30	0.060	0.69	5.26	8.19
S - 19	7.90	0.098	1.09	0.046	1.50	4.98	8.19
S - 22	8.11	0.092	0.88	0.046	0.56	4.82	8.19
S - 23	9.17	0.094	0.93	0.061	0.71	4.88	8.21
S - 26	8.20	0.080	0.42	0.036	0.46	4.66	8.22
S - 27	9.53	0.113	0.60	0.049	0.89	4.94	8.21
S - 31	5.30	0.142	0.48	0.070	0.64	5.75	8.23
S - 32	3.51	0.112	0.79	0.063	1.43	5.19	8.23
S - 37	1.29	0.100	0.49	0.074	0.46	5.45	8.23
S - 40	1.98	0.080	0.50	0.059	1.02	5.11	8.23
S - 42	3.05	0.085	0.66	0.057	1.24	5.09	8.23
S - 43	2.66	0.087	0.57	0.052	0.87	5.05	8.24
S - 46	1.27	0.105	1.65	0.055	0.69	5.24	8.23



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A comparative study on some heavy metal concentrations (Zn, Cu, Pb, Cd, Ni, Cr) in the sediments from Homa (Izmir) and Karine (Aydin-Türkiye) Fisheries Lagoons

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Homa and Karine are the most important fisheries lagoons in Ege region. Mean dephts of Homa and Karine fisheries lagoons are 0.50 m. and 1 m. Homa fisheries lagoons has 1800 ha. square and Karine fisheries lagoon has 8500 ha. square. Annual fish production varied in between 30-60 tons for Homa and 95-110 tons for Karine.

Sediments were collected from 5 different stations with a benne "Orange-peel" of capacity 4.5 l. This study was carried out on May, August and November 1991 in Homa, on November 1991 in Karine.

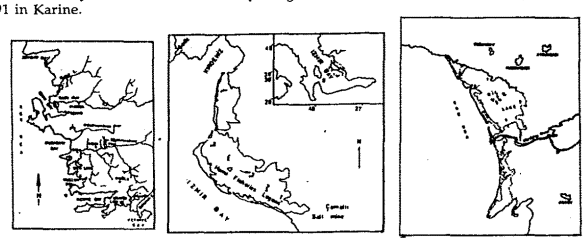

Fig. 1. Localisations of stations in Homa and Karine fisheries laggoons (1. Homa, 2. Karine)

All sediment samples were stocked in the plastic bags. Each sample was ovendried at 60°C for 24 h. and then sieved, using a 160 µm. From the dried sediment samples a quantity of 1 g. (<160 µm) was degisted with conc. HCl: HNO_3 (3:1 v/v Merck) under the reflux at 120°C ror 2 h. and then filtered with Whatman filter-paper. All samples were diluted to 50 ml with bidistilled water (ARNOUX *et al.*, 1981) and assayed using AAS 2380 Perkin-Elmer Atomic Absorption Spectrophotometer.

We were given the heavy metal concentrations in the sediments from Homa and Karine fisheries lagoons in Table I.

Table I. Some heavy metal concentrations in the sediments from Karine and Homa fisheries lagoons (µg/g dry weight).

KARİNE						
Zn	Nov.	33.5	63.0	45.0	42.0	54.0
Cu	Nov.	20.0	20.0	15.0	14.0	18.0
Pb	Nov.	40.0	35.0	40.0	15.0	30.0
Cd	Nov.	2.0	1.5	25	2.0	1.5
Ni	Nov.	260	279.5	264.0	237.5	258.5
Cr	Nov.	45.0	49.0	31.5	53.5	51.5

HOMA						
	Stations	1	2	3	4	5
Zn	May.	82.0	100.0	90.0	87.0	71.0
	Aug.	54.0	63.0	72.0	135.0	93.0
	Nov.	51.0	63.0	69.0	114.0	81.0
Cu	May.	26.5	20.0	22.5	26.5	20.0
	Aug.	17.0	26.0	23.5	24.0	24.0
	Nov.	19.0	19.5	20.5	17.5	14.0
Pb	May.	40.0	32.0	35.0	36.5	42.0
	Aug.	45.0	50.0	55.0	55.0	60.0
	Nov.	65.0	70.0	80.0	75.0	35.0
Cd	May.	2.0	2.0	2.0	2.5	2.5
	Aug.	1.5	3.0	2.5	2.5	4.5
	Nov.	2.5	1.5	2.0	2.5	2.0
Ni	May.	113.5	100.0	110.0	119.0	95.5
	Aug.	87.0	121.0	113.5	104.5	109.5
	Nov.	97.0	100.5	105.0	97.0	77.0

Homa fisheries lagoon takes part in outer Bay of Izmir and it is influenced on the sewages which come from Gediz River and very polluted inner Bay of Izmir (YARAMAZ, ALPBAZ, 1990).

Karine fisheries lagoon takes part in Southern Ege and it is influenced on the sewages from Menderes River.

According to our results, heavy metal concentrations of Homa sediments are higher than Karine sediments.

According as Table II, heavy metal concentrations of Homa and Karine sediments are lower than inner Bay of Izmir thus there is no risk in point of heavy metal pollution in these fisheries lagoons now.

Table II. Comparison of Heavy metal concentrations in the sediments from Homa fisheries lagoon, Inner and Middle Bay of Izmir and Venice lagoon (µg/g dry weight).

Localite	Zn	Cu	Pb	Cd	Cr	References
Inner Bay of İzmir	61-899	16-213	13-305	1.3-6.6	21-237	Gey, Mordoğan, 1988
Middle Bay of Izmir	38.5-110	12.5-28.5	41.3-61.0	2.0-5.0	-	Yaramaz et al. 1991
Homa fisheries lagoon	32-68	19-27	10-95	2-5.5	43-78	Yaramaz et al. 1990
Venice lagoon	61-5930	21-463	3.1-278	1.1-25.4	-	Pavoni et al. 1987

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C

Flore spongique de la Lagune Sinoé

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La signification économico-sociale de la présence des champignons dans le milieu lagunaire est liée à leur propriété de parasiter et de dégrader la substance organique vive ou morte (JONHSON, 1970).

Nos études effectuées dans la zone littorale polluée de la mer Noire ont mis en évidence une nette liaison entre la quantité de spores viables et le contenu organique de l'eau de mer (APAS, 1988, 1989).

Au cours de l'année 1990 on a obtenu des données préliminaires sur la dynamique et la structure des populations de micromycètes de la lagune Sinoé du Delta du Danube.

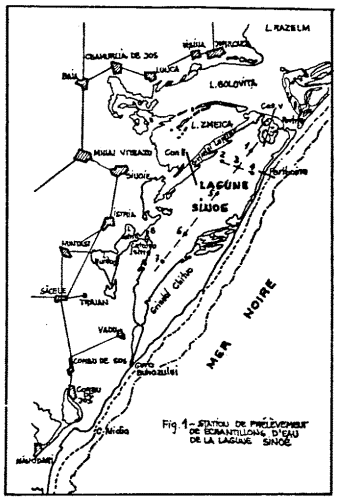

Figure 1. Station de prélèvement des échantillons d'eau de la lagune Sinoé

Les échantillons biologiques furent prélevés de 5 stations de la partie nord de la lagune, dans l'intervalle avril-september (Fig. 1). Du point de vue quantitatif on a identifié 13 taxons appartenant aux ordres *Blastomycetes, Coelomycetes, Hyphomycetes, Saprolegniales, Peronosporales* et *Mucorales.*

Les espèces *Saprolegnia* sp., *Pythium* sp. et *Stemphylium laminarium* sont accidentellement marines.

Candida sp. et *Penicillium crysogenum* ont été considérées dominantes, ayant une large distribution dans tous les secteurs étudiés. Après *Aspergillus fimugatus, A. flasus, Rhodotorula rubra* et *Penicillum* sp. (formes caractéristiques aux eaux lagunaires salées). On a fréquemment rencontré aussi *Rhizopus* sp. et *Cephalosporium* sp., mais en petites quantités. Des formes très importantes dans la structure du mycoplancton ont été *Achya* sp. et *Brachiomyces* sp.

La production moyenne de spores par stations et par mois a été de, respectivement, 2740 sp.l^{-1} et 2283 sp.l^{-1}, ce qui dépasse d'environ 6 fois les quantités admisibles de ces organismes par unité de volume d'eau.

On a observé la division du mycoplancton en deux groupes écologiques: champignons levuriformes et champignons filamenteux. Un développement plus évident ont enregistré ceux levuriformes, surtout dans les stations 1, 2, et 4 (Fig. 1), représentant 60 % de la production totale.

Le développement maximal dans les stations marginales a été réalisé sur le compte des formes pathogènes *Candida* sp. et *Rhodotorula* sp., ce phénomène étant dû aux fortes influences terrigènes, auxquelles s'ajoutèrent les autres formes, aussi bien allochtones qu'autochtones.

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La Pêche et les Poissons dans le Système Lagunaire de Koycegiz (Turquie)

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Ce système lagunaire est constitué du lac de Koycegiz, des canaux et des étangs, ce qui forme presque un labyrinthe. Certaines recherches qui ont été réalisées jusqu'à présent ont eu comme objet l'hydrologie, l'écologie et les poissons de ce système (NUMANN, 1954, 1958; AKYARLI, 1980; CATAUDELLA, 1983; BALIK et USTAOGLU, 1984; CATAUDELLA et FERLIN, 1984; BALIK, 1988; OZHAN, 1988; YERLI, 1989). Le lac de Koycegiz qui appartient à la catégorie des lacs de barrage d'alluvial se trouve dans la région sud-ouest de l'Anatolie. La superficie de ce lac est de 55 km2, mais avec les canaux et les étangs il atteint les 60 km2. Entre le lac et la mer, il y a un canal principal de 12 km de longueur et d'autres canaux secondaires se reliant à celui-là. On trouve trois bordiques très productives sur ces canaux. Dans cet écosystème très compliqué, naissent des courants d'eau qui ont pour origine les marées basses et les marées hautes de la Méditérranée. Ces courants changent de direction au moins deux fois par jour, allant de la mer vers le lac et puis du lac vers la mer. Certains poissons et généralement leurs alevins entrent dans cet écosystème par les stimulations des courants d'eau qui s'écoulent vers la mer. Dans la région delta qui ressemble à un labyrinthe se trouvent beaucoup d'herbes aquatiques comme les *Juncus maritimus, Fragmites communis, Thypha latifolia.* La salinité du système présente des variations dans les différentes localités et elle se situe entre 2‰ et 12‰ (Tabl. 1). C'est pourquoi, ce système lagunaire fait partie des lacs mésohalines des eaux salées. Entre ce système et la mer Méditérranée on trouve une bande de sable très importante de 7 km de longueur. Certaines tortues marines *(Caretta caretta)* font leurs nids et déposent leurs oeufs dans cette plage excellente. C'est pourquoi, cette bande de sable qui est un lieu de séjour très favorable pour *Caretta caretta* est très soigneusement protégée par les lois Turques.

Paramètres	Min.	Max.	Moyennes
Température (°C)	19.3	19.8	19.56
pH	7.22	8.26	8.04
Salinité (‰)	2.34	12.35	5.63
L'oxigène dissous (mg/l)	7.00	9.60	8.35
Conductivité (µmhoms/cm)	2625	50000	9178
Turbidité (cm)	74	820	234

Tableau 1.- Les variations annuelles des paramètres étudiés.

Les espèces de poissons qui vivent dans ce systéme lagunaire sont les suivants: *Mugil cephalus, Liza ramada, Liza saliens, Liza aurata, Chelon labrosus, Sparus aurata, Dicentrarchus labrax, Anguilla anguilla, Pagellus mormyrus, Diplodus annularis, Epinephelus aeneus, Lichia amia, Cyprinus carpio, Silurus glanis, Leuciscus cephalus, Barbus plebejus escherichi, Capoeta capoeta, Atherina boyeri, Gambusia affinis, Tilapia sp.* Seulement une espèce parmis ces poissons *(Tilapia sp.)* a été introduite dans cet écosystème en 1989. Certains poissons vivant dans cet écosystème ont une valeur économique importante au point de vue nourriture pour l'homme. La pêche, dans ce système, est pratiquée par une coopérative comptant 600 membres. La plupart des poissons s'obtiennent des bordiques qui sont sur les canaux et d'autres aussi se pêchent des lacs et des étangs. La production annuelle est d'environ 350 tonnes de poissons et de 5 tonnes de caviar de Muges (Tabl. 2).

Années	Muges	Bar	Dorade	Anguille	Carpe	Caviar	Total
1975	245229	2484	1429	5785	41639	5920	296566
1980	202236	5406	4843	6933	30367	5897	249785
1985	123495	7145	4533	18862	24466	3917	178501
1990	277044	4423	8120	15181	33026	6068	337794

Tableau 2.- La production annuelle de la pêche dans le système lagunaire de Koycegiz (en kg)

La plupart de la production provient d'espèces de Muges, de la carpe et de l'anguille. En effet, "les Muges d'Eté" *(Mugil cephalus)* et "les Muges d'Hiver" *(Liza ramada)*, à l'époque des migrations du lac de Koycegiz vers la mer Méditérranée, entrent dans ces bordiques et s'y groupent.

En conséquence, le système lagunaire de Koycegiz montre un exemple d'écosystème très productif en Turquie tant du point de vue de la pêche commerciale que de l'activité touristique.

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E

Les dominantes parasitologiques dans les élevages de Poissons marins en Tunisie

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.ntroduction

L'aquaculture représente un des secteurs économiques d'actualité en Tunisie.

Les exploitations aquacoles qui se développent actuellement en Tunisie concernent, dans leur majorité, l'élevage intensif d'espèces de poissons de haute valeur commerciale (loup, *Dicentrarchus labrax* et daurade, *Sparus aurata*) (BOUSSAID, 1987).

Le suivi pathologique de ces exploitations nous a permis de mettre en évidence différentes affections qui surviennent chez les poissons au cours des différentes phases de la croissance (alevins, juvéniles, adultes). Dans ces affections, les dominantes pathologiques sont les maladies d'origine parasitaire. Nous allons citer les principales parasitoses rencontrées.

Les principales parasitoses

1 - Amyloodiniase: Cette affection due à un Protozoaire Dinoflagellé Péridimien, *Amyloodimium ocellatum* est survenue chez le loup, *Dicentrarchus labrax*, chez des alevins en cours de prégrossissement mais aussi chez des juvéniles en cours de grossissement. D'une façon générale, dans ces phases de l'élevage, les pertes occasionnées sont considérables (taux de mortalité de 60 à 100 %) car plus le poisson est de petite taille et plus le seuil de pathogénicité est rapidement atteint.

Amyloodinium est connu dans diverses piscicultures dans le monde. En Tunisie, il s'agit de la première mention de ce dangereux parasite qui provoque des dégénéréscences de cellules de l'épithélium branchial et ou tégumentaire. Le tissu parasité prend un aspect blanchâtre feutré.

E

2 - Trichodiniase: Il s'agit d'une affection largement répandue dans le monde. Elle est due à des Protozoaires Ciliés Péritriches qui se localisent au niveau du corps et des branchies des poissons.

En Tunisie, cette affection est survenue chez des daurades *(Sparus aurata)* en cours de grossissement mais aussi chez des alevins de loup *(Dicentrarchus labrax)* en cours de prégrossissement. Ces parasites provoquent, à l'aide de leurs denticules oraux, une érosion de l'épiderme et/ou de l'épithélium branchial.

3 - Helminthose : La seule helminthose que nous avons rencontrée dans les installations piscicoles tunisiennes est due au Monogène *Diplectanum aequans* qui parasite les branchies du loup au cours du grossissement .

La pullulation de ce monogène peut se traduire par des mortalités massives, déjà signalées dans d'autres piscicultures méditerranéennes (SILAN, 1984).

4 - Copépodose: Il s'agit d'une affection grave, très répandue dans nos exploitations piscicoles. Elle est due à la pullulation d'un copépode parasite, *Caligus minimus* chez les géniteurs du loup, *Dicentrarchus labrax*. Les poissons parasités sont porteurs de plusieurs dizaines de Caligides dans la cavité buccale et sur tout le coprs, particulièrement au niveau de la tête et des nageoires où des plages déchiquetées et hémorragiques plus ou moins étendues sont toujours observables (BEN HASSINE et BOUSSAID, 1988).

Conclusion

Le suivi pathologique des exploitations piscicoles tunisiennes nous a permis de constater que quel que soit le type d'élevage et l'espèce cultivée, toutes les stations piscicoles ont été confrontées à des problèmes pathologiques d'origine parasitaire. Il est, par conséquent, indispensable d'envisager de moyens de lutte contre les parasites au moment même de la conception de l'installation. Parmi ces moyens de lutte, les méthodes préventives sont celles qui doivent être recherchées en priorité car elles sont sans danger pour l'hôte et pour l'environnement.

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Fish abundance and distribution in s'Abulfera, an oligohaline coastal marsh in Mallorca (Balearic Islands)

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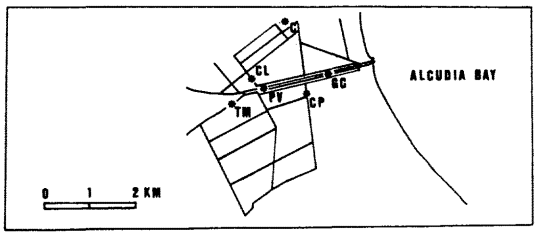
Although s'Albufera is the most important oligohaline coastal environment of the Balearic Islands, little is known aboutits fish community. From faunistic information, RIERA (1980) concluded taht species richness decreased from the outlet of the central channel to the inner part of the marsh, due to the existence of a salinity gradient. In order to verify this pattern, and determine how fish biomass is distributed within the marsh, catch per unit effort (CPUE) was obtained by means of trammel nets at six sampling stations in early October (1991), when autumnal migrations to the sea had not yet begun.

Salinity was low at stations GC, PV, CP, TM and CL (4.3±0.75 ppt), in which waters were neutral (pH = 7.51±0.14) and moderately rich in dissolved oxygen (predawn $[O_2]$ = 6.25±0.84 ppm; sunset $[O_2]$ = 8.84±0.89 ppm). Station C had a higher salinity (10 ppt) but did not differ from the others in oxygen concentration or pH.

If biomass is considered, the community is dominated by *Chelon labrosus* (25.15%), *Dicentrarchus labrax* (31.31%) and *Liza ramada* (26.10%). Other members of the community are *Anguilla anguilla* (3.05%), *Lichia amia* (1.82%), *Lithognthus mormyrus* (3.31%), *Liza aurata* (2.08%), *Liza saliens* (3.68%) and *Mugil cephalus* (5.45%). Diversity (H' = 0.671±0.088) and species number (N = 4.2±0.99) are nearly constant among fishing sites and they are not correlated with the distance to the sea through the central channel or the water quality parameters.

But this does not mean that fishes were homogeneously distributed. In fact, *A. anguilla* , *L. aurata* and *L. saliens* have a random distribution, whilst the other species seem to conentrate in the central channel (stations GC and PV) (F test). As a consequence, total CPUE, expressed as grams of fish per m2 of net and hour of fishing, is higher at the stations on the central channel (GC: 16.30; PV: 15.61) than at those in peripheral areas (CP: 1.66; TM: 1.37; CL: 5.04; C: 0.58) (T test). As neither the distance to the sea nor any water quality parameter is correlated by other factors.

Peripheral channels and lagoons are not freely connected with the central channel, due to the existence of sluices and vegetal obstructions. Moreover, the central channel is richer in submerged fanerophytes than peripheral areas and high submerged plant abundance has been correlated with high fish populations (COMIN *et al.*, 1991). Therefore, studies on peripheral area accessibility and food availability are needed for a further understanding of fish distribution in the marsh.



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Etude biologique d'*Artemia* dans la Saline de Sfax (Tunisie)

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De janvier à novembre 1987, *Artemia* a été étudiée du point de vue quantitatif et qualitatif dans la saline de Sfax (Sud Tunisien). Ce phyllopode a été signalé en Tunisie, dans divers plans d'eaux salés tels que Sebkhas, Chotts et salines (BEN ABDELKADER, 1985) et l'espèce a été attribuée à *tunisiana* aprés identification par croisement avec la souche de Larnaca (VAN BALLAER *et al.*, 1937).

Durant la période d'étude *Artemia* a été observée dans tous les bassins de salinité supérieure a 140‰ avec une densité qui varie inversement avec le taux de salinité. La limite inférieure de la distribution spatiale n'est pas due à l'intolerance de l'espèce aux salinités plus faibles mais plutôt à l'absence de prédateurs tel que *Cyprinodon fasciatus* dans ces eaux (SORGELOOS, 1980).

Dans ce travail, nous donnerons les résultats obtenus dans un bassin du partenement intérieur de 30cm de profondeur et de salinité moyenne 253‰. Ce paramètre est maintenu presque constant par une circulation appropriée des eaux dans le cadre du fonctionnement de la saline. Les prélèvements réguliers effectués environ tous les 20 jours ont été analysés en fonction des caractères hydrologiques du milieu.

Distribution saisonnière.
L'abondance d'*Artemia* présente des fluctuations temporelles nettes avec un accroissement de la densité moyenne jusqu'au mois de mai (255 ind/l) puis une décroissance jusqu'en juillet. Au mois d'août *Artemia* disparaît complètement. Cette évolution est régie par les conditions ambiantes; le pic de mai est lié à l'existence de facteurs favorables aussi bien biotique (ressource trophique) qu'abiotiques (température et oxygène) alors que la disparition en août peut être attribuée à la température qui devient léthale quand elle depasse 30°C (THOEYE *et al.*, 1987).

Sex-ratio.
Artemia tunisiana étant une souche bisexuée, mâles et femelles sont présents dans le milieu et atteignent des tailles variant de 9 à 5,3 mm pour les premiers et 10,6 à 6,7mm pour les deuxièmes. La proportion des sexes fluctue en fonction du temps. Jusqu'en avril la sex-ratio est en faveur des mâles puis s'équilibre par la suite quand les conditions deviennent défavorables.

Reproduction.
Les modes ovipares et vivipares ont été observés durant toute la période d'étude. A part le mois de janvier, les femelles ovipares ont dominées et ont atteint en mai un taux de 87,3%. De tels résultats ont déjà été mentionnés en milieu naturel et les élevages en laboratoire ont mis en évidence le fait que pour la plupart des espèces les premières générations sont assurées par l'émission directe de nauplii, les oeufs de durée sont produits par la suite. Cette situation est motivée d'une part par le repeuplement rapide et efficace de l'habitat et d'autre part par le souci de sauvegarde de la pérennité de l'espèce dans les milieux où sa survie est menacée (AMAT, 1982). Des cystes brun-orangés ont été observés dans le bassin à partir du mois de février.

Fecondité.
Quelque soit le mode de reproduction, la fécondité moyenne a diminué à partir du mois de février, période au cours de laquelle elle a atteint un maximum de 47,9 oeufs ou 39,6 nauplii/femelle jusqu'au mois de juillet avec 14,2 oeufs ou 39,6 nauplii/femelle. Cette baisse est probablement liée aux modifications des paramètres environnementaux tels que la température, l'oxygène et la richesse trophilique. Le rôle du facteur génétique n'est pas non plus à negliger et pourrait expliquer les faibles valeurs enregistrées par rapport à celles signalées chez d'autres populations (jusqu'à 300 oeufs/femelle).

Recrutement.
Durant toute la periode d'étude divers stades de développement ont été rencontrés (nauplii, juvéniles, pré-adultes et adultes). Ce sont les juvéniles qui constituent l'élément dominant (92% en mars). La présence constante des nauplii (sauf enjJuillet) laisse supposer que le recrutement est continuel dans le bassin d'étude. Ce processus est assuré par les vivipares d'une part et l'éclosion d'oeufs de durée après les fortes pluies de printemps (mars et avril), d'autre part.

Dans ce milieu hostile, *Artemia* est bien adaptée et développe des mécanismes de survie. Elle module ainsi ses caractéristiques biologiques (densité, mode et capacité de reproduction etc...) en fonction des changements ambiants, disparaît quand la température devient léthale et réapparaît après les pluies d'automne.

Mois	S°/oo	T°C	O_2 O_2 mg/l	Densité moyenne	% femelle	% fem. ov.	Fec moy ov.	Fec.moy viv
Janvier	250	14	2,9	65,1	37,2	35,7	30,5	28,7
Février	256	15	2	71,9	39,1	72,2	47,9	39,6
Mars	260	17	2	137,4	42,9	78,1	27	34,4
Avril	250	23	1,7	255,2	40	83,3	23	23
Mai	254	24	1,7	78,1	49,6	87,3	18,5	21
Juin	262	27	1,5	47,5	52,4	82,2	18,4	19,5
Juil.	251	29	1,8	4,6	50	57	14,2	13,9
Août	250	34	1,1	0	0	0	0	0
Sept.	252	26	1,2	0	0	0	0	0
Oct.	252	22	2,6	0	0	0	0	0

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Recherches sur les aspects physico-chimique et biologique de la Lagune de Karina (Aydin, Turquie)

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La lagune de Karina se trouve dans la partie occidentale de l'Anatolie, près de la fameuse cité antique de Milet. Elle se situe à 27° 10' E et 37° 35' N et elle a une superficie de 8500 ha.

Les prélèvements physico-chimiques et biologiques ont été réalisés dans 5 stations (Fig. 1) et les résultats sont présentés sous forme de tableaux (Tableaux 1, 2).

Tableau 1. Les paramètres physico-chimiques de la lagune de Karina

Station	1 Se 91	1 Ja 92	2 Se 91	2 Ja92	3 Se 91	3 Ja 92	4 Se 91	4 Ja 92	5 Se 91	5 Ja 92
T °C	22,23	9,1	22,6	9	22,3	9	22,3	9,1	22,3	9,15
pH	7,88	7,55	7,87	7,34	7,89	7,29	7,82	7,5	7,94	7,3
Sal ‰	41,08	36,27	40,6	36,85	40,36	36,85	38,2	35,1	38,61	36,27
NO_2-N µg at.l^{-1}	0,02	---	0,02	0,02	---	0,04	0,02	0,04	0,04	0,04
NO_3-N µg at.l^{-1}	0,02	0,235	0,04	0,11	0,04	0,23	0,10	0,05	0,04	0,05
NH_4-N µg at.l^{-1}	2,96	5,74	2,70	5,53	4,72	5,26	2,96	6,74	5,40	5,55
NH_3-N µg at.l^{-1}	0,20	0,32	0,17	0,30	1,47	0,28	0,19	0,38	0,36	0,30
PO_34-P µg at.l^{-1}	0,80	1,14	0,63	1,14	0,68	1,08	0,86	1,19	0,91	1,26
S mg.l^{-1}	0,11	0,03	0,14	0,04	2,62	0,07	0,18	0,08	0,18	0,04

Tableau 2. Les poissons de la lagune de Karina et les pêches (%)

Espèces	La pêche (%)
Mugil cephalus cephalus	
Chelon labrosus	
Liza ramada	55
Liza aurata	
Sparus aurata	20
Dicentrarchus labrax	10
Solea vulgaris	10
Anguilla anguilla	5

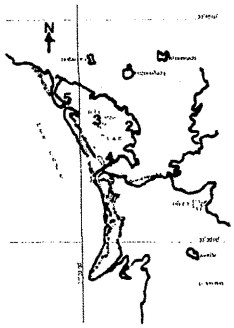

Figure 1. Stations de prélèvement physico-chimique et biologique

D'après ces résultats, cette lagune présente une potentiel importante du point de vue des sels nutritifs et des ressources vivantes. D'ailleurs la production annuelle de poisson varie entre 90 et 120 tonnes.

Les Diatomées pennées sont abontantes dans la richesse floristique de cette lagune. Exemples: *Climacosphenia moniligera, Cyrosigma scalproides, Nitzschia ventricosa, N. sigma, Rhabdonema adriaticum, Melosira varians, Synedra ulna, S. undulata, Amphiprora alata* and *Fragilaria hyalina.*

Elles constituent la nourriture des Mugilidés dans ce type milieu saumâtre (KIENER, 1978).

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E

A model of competition between primary producers in Coastal Lagoons

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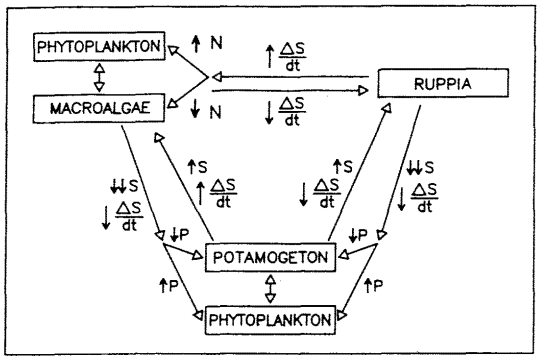
Mediterranean coastal lagoons show many types of salinity-temperature relationship. Because of climate conditions, the increase in salinity during the summer is a common feature under non-perturbed conditions. However, human influences can alter the hydrology of the lagoons, which can result in striking changes in the biological community living in the lagoons.

The coastal lagoons in the delta of the Ebro River have been affected by human agricultural practices for over a century. The consequence was a change in the hydrological regime: decreasing salinity (35-1 ppt) during May-October due to the discharge of freshwater from irrigated ricefields and increasing salinity (1-35 ppt) during November-April due to water exchanges with the sea (COMIN, 1984). Biological populations adapted to these seasonally fluctuating conditions include submerged rooted macrophytes (*Potamogeton pectinatus* and *Ruppia cirrhosa* which developed every year in the lagoons according to these salinity-temperature fluctuations (MENENDEZ & COMIN, 1989). In highly eutrophic lagoons, submerged rooted macrophytes disappeared after the water column became very turbid, because of phytoplankton blooming (COMIN *et al.*, 1990). These results obtained comparing different coastal lagoons in the Ebro Delta were used to propose a simple model of competition between primary producers (phytoplankton *versus* submerged rooted macrophytes). Light and nutrients were the key factors for the result of the competition. Cultural eutrophication, increasing freshwater discharges to the lagoons containing huge amounts of nutrients, favoured phytoplankton proliferation, which in turn increased light extinction in the water column and prevented submerged rooted macrophyte development. No data are available on the influence of other factors, such as biocides used intensively for agriculture and changes in the characteristics of the sediments.

However, this model is too simple considering the variety of plants which can contribute to primary production in coastal lagoons and the range of environmental conditions affecting the same coastal lagoon through time. Floating macroalgae developed a huge population in a coastal lagoon in the Ebro Delta (Tancada) in two years (1990-91) after water management practices prevented freshwater inputs to the lagoon. The water of the lagoon became hypersaline during summer (conductivity 65 mS cm^{-1}, while it had ranged between 50 and 5 mS cm^{-1} in previous summers). At the same time, the nitrogen concentration in the water changed from relatively low nitrate (1-8 µg-at l^{-1}) and high ammonium (1-50 µg-at l^{-1}) before 1990 to relatively high nitrate (1-30 µg-at l^{-1}) and low ammonium (0-1 µg-at l^{-1}) during 1990. Again, relatively low nitrate and high ammonium concentrations were observed during 1991. No significant changes were observed in the phosphorus concentrations. During these two years, phytoplankton biomass did not increase significantly and both the area covered by *Ruppia cirrhosa* and its biomass per area decreased compared to previous years. As floating macroalgae (*Ulva rigida, Chaetomorpha linum, Cladophora* sp.) did not develop large populations in previous years, a more realistic model of competition between primary producers in coastal lagoons is proposed here (Fig. 1).

Fig. 1.- Schematic representation of the model of competition between primary producers in coastal lagoons. Arrows between boxes indicate the changes of populations dominating the primary production. (N-Nitrogen, P-Phosphorus, S-Salinity, delta S/dt-rate of salinity change. Upward arrows: increase, downward arrows: decrease).



The substantial proposal of this new model is the contrast between the nutrients through which the control of competition between primary producers is exerted. Phosphorus at low salinity and nitrogen at high salinity would be the key nutrients. In both cases, phytoplankton would take the lead at high nutrient concentration while macroalgae having a high affinity for nitrogen would decrease nitrogen concentration in the water, as in 1990, and would proliferate. In any case, phytoplankton and macroalgae can bloom rapidly because of their high growth rates, accumulating huge biomasses in the water column and limiting available light available for submersed rooted macrophytes.

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Caractérisation biochimique de trois populations d'*Atherina boyeri* des Milieux Lagunaires Méditerranéens

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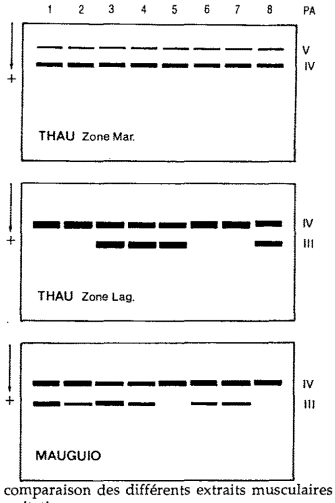
L'espèce *Atherina boyeri* (RISSO, 1810) est considérée par de nombreux auteurs comme constituant un complexe polymorphique (KIENER et SPILLMAN, 1969, 1972; KARTAS et TRABELSI, 1990).

Résistante aux fortes variations de température et de salinité, cette athérine est capable de coloniser les eaux douces mais son domaine de prédilection reste toutefois la frange côtière marine et surtout les eaux saumâtres lagunaires.

Dans le bassin de Thau, l'analyse statistique du nombre de vertèbres (v), de rayons aux nageoires pectorales (Pe) et de branchiospines (Br) a permis de distinguer deux populations: l'une occupant la zone marine de ce bassin (n=100; v=45,780, s=0,917; Pe=15,050, s=0,539; Br=35,550, s=1,149) et l'autre la partie lagunaire (n=100; v=44,510, s=0,859; Pe=14,210, s=0,656; Br=26,090, s=1,026).



Dans l'étang de Mauguio, seuls des individus présentant les caractéristiques de la population lagunaire de Thau sont présents (n=100; v=44,510, s=0,798; Pe=14,180, s=0,657; Br=26,330, s=1,215).

Une approche mettant en oeuvre les techniques d'électrophorèse des protéines musculaires a été entreprise dans le but de chercher si les divergences morphologiques mises en évidence se retrouvent au niveau biochimique.

L'étude a porté sur l'analyse électrophorétique des parvalbumines présentes dans des extraits musculaires d'athérines. Ces protéines constituent un bon critère d'identification en raison de l'existence de plusieurs isoformes et de leur grande spécificité (FOCANT *et al.*, 1988, 1990, 1991).

Les électrophorétogrammes de la figure résument la répartition des isoformes des parvalbumines présentes. Celles-ci correspondent aux isoformes III, IV et V de la carpe.

La comparaison des différents extraits musculaires révèle une certaine diversité qualitative et quantitative :

- L'isoforme IV est présente aussi bien chez les athérines à affinité marine (Thau) que lagunaire (Thau et Mauguio).
- Les différences observées entre les populations de ces deux milieux portent sur les isoformes III et V. La première (PA III), quand elle existe, se trouve exclusivement, mais en proportions variables, chez les poissons à affinité lagunaire. La seconde (PA V) s'observe uniquement chez les athérines à affinité marine.

Les divergences biochimiques enregistrées confortent, dans l'ensemble, les résultats fournis par la méthode biométrique, à savoir la présence sur les côtes du Languedoc de populations marines d'*Atherina boyeri* distinctes de populations inféodées aux milieux lagunaires.

Ces différences traduisent la malléabilité de ce poisson et font de lui un excellent bio-indicateur du milieu.

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Planktonic rotifers as indicators of pollution in Mediterranean coastal lagoons of Egypt

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Rotifers are known to be excellent indicators of organic pollution as they thrive better in organically rich environments. Comparative investigation of Egyptian lagoons showed that cleaner environments are the lowest in standing crop as well as in species richness, whereas eutrophic areas sustain the greatest number of both individuals and species.

The coastal lagoons investigated are Menzalah, Edku and Maryut (Fig. 1). All are shallow and low brackish receiving their waters mainly from agricultural drains. L. Menzalah and L. Edku are connected to the sea, but L. Maryut has no free connection.

L. Maryut receives also mixed industrial and domestic waste waters, and is heavily polluted (SAAD, 1980). Observations covering 16 months on the 2 drains feeding L. Maryut (relatively clean water, before mixing with lake water) showed that monthly average zooplankton standing crops of respectively 7 and 2.4 org.l^{-1} with about equal proportions of Rotifera, Cladocera and Copepoda. Rotifers were represented by 6 to 11 species belonging to 6 genera. After mixing with lake water, the drains standing crops increase sharply to 90 org.l^{-1}. Rotifers contributed by an average of more than 65 % of the total. The number of species also increased to 20 belonging to 9 genera. At the seaward outlet of Umum drain, where dilution with sea water occurs, the zooplankton standing crop dropped to about 55 org.l^{-1}. Rotifers were still leading, but the number of species decreased to 13. In all cases (within the outlet and in the other parts of the lake) Brachionus calyciflorus was the dominant followed by B. plicatilis and Synchaeta spp. (GUERGUESS, 1988).

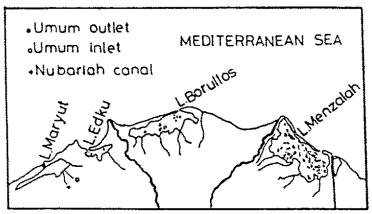

Figure 1. Map of the coastal lagoons

L. Menzalah is highly eutrophic as it receives agricultural runoff mixed with domestic waste waters. Observations troughout 17 months on an area downstream from the effluent showed monthly average standig crops of 93 org.l^{-1}. Rotifers contributed by an average of more than 56 % to the total and were represented by 14 species belonging to 7 genera. *B. calyciflorus* (49 %) was leading, followed by *B. urceolaris* (2 %) and *Keratella quadrata* (1%). In another area remote from the effluent, the average standing crops dropped to 26 org.l^{-1}. Rotifers contributed by an average of only 3.2 % to the total. They were represented by 6 species (GUERGUESS, 1979).

L. Edku waters are relatively clean. Rotifers contribute by an average of less than 10% (3.4 org.l^{-1}, 21 months of observations). 16 species of Rotifers belonging to 7 genera were recorded. *B. calyciflorus* (3 %), *B. urceolaris* (3 %) were the more important followed by *K. quadrata* (1%) and *B. angularis* (0.4 %).

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Lenght-weight relationships in Gilthead Seabream (*Sparus aurata* L., 1758), catched from Homa Lagoon (Izmir, Turkiye)

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There are many bays and gulfs at the shore of Aegean Sea. These areas are suitable for natural fish production. There are 26 active lagoons of about 35000 ha which yield a productivity of 5 - 6 kg/da at Türkiye (ALPBAZ, 1987). Gilthead Seabream (*Sparus aurata*) are very frequent in the lagoon areas of our country since is an important commercial fish for all mediterranean countries. Studies have been done about their body lenght-weight relationships in the lagoons.

The studies have been performed in Homa Lagoon located north west of Izmir Bay (fig. 1). The total area of lagoon is 18000 da., and its average depth is 0,75 m. Around 15000 da. of this area are suitable for fishery. The lagoon is connected to the sea bay six canals. The total fish production in 1989, the period of the present investigation, was 65 ton/year, 15 percent of this was Gilthead Seabream (KORKUT, 1989).

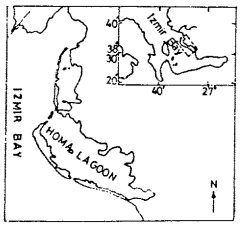

Fig. 1. Homa Lagoon

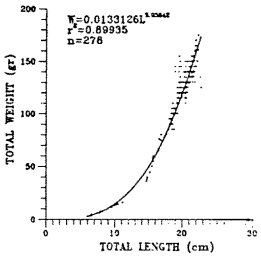

Fig. 2. Length-weigth relationship in *S. aurata*

Gilthead Seabream were cathched by gillnets, fyke nets and traps. Lenght and weight measurements have done to observe growth. The parmeters of the length(L)/weight(W) regression curves were calculated using the equation: $W=aL^b$ (fig. 2). For statistical analysis these curves were the transformed into straight line equations. The proportions of individuals of each length class are given at figure 3.

According to our observations Gilthead Seabream reach, in six months, about 170 g in weight and 18.46 cm in length.

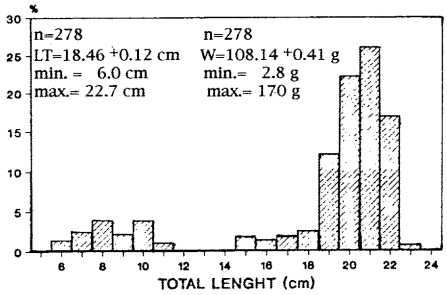

Fig. 3. Proportion of different lenght classes in Gilthead Seabream (*Sparus aurata* L., 1758).

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E

The primary production of the Salt Lake of Mesolongi, Greece

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Introduction

The water of the salt lake of Mesolongi, which is a salt-works entreprise, is under special management: It is being pumped and moved in the various parts of the salt-works, where it is retained in evaporation ponds for time intervals which differ from one to the other. The time intervals are long enough to create different parameters (temperature, salinity, pH, etc.) from one pond to the other. The purpose of this study was to measure the primary production of the various parts of the Salt Lake of Mesolongi.

Material and methods

The primary production of the Salt Lake was determined by measuring the photosynthesis by the "light and dark bottle" method. Estimates were made in two selected dates, one in the middle of the Spring and the other in the middle of the Autumn.

The experimental procedure as it is described by STRICKLAND and PARSONS (1972) was followed. For the required determinations 16 stations were selected, covering all the area of the salt-works. The incident and absorbed by the water energy was calculated from the meteorological data for the solar radiation of the area of Mesolongi.

Results and discussion

The results of the gross and net photosynthesis, as well as respiration were calculated in mg C/m^3 per hr and they are given on the table.

From the results it is concluded that the different parts of the lake function like different ecosystems, although they are not completely isolated and separated. As a general classification, these "systems" can be grouped into three broader groups.

The first group includes the very last parts of the salt works, i.e. the evaporation ponds before the crystallizers. It is the most infertile area of the lake. The second group includes the evaporation ponds at the beginning of the salt-works. GP is small in April and satisfactory in October. The third group are the evaporation ponds in the middle of the lake. The highest production occurs in these ponds and the most productive station is included in this area.

It must be noted that all the stations have shown gross primary production. Furthermore, in all the stations respiration was detected. It is therefore obvious that the primary producers are found all over the salt lake. As it can be seen from the results, the energy lost in respiration by the autotrophs varies in the various ecosystems.

Table : The Primary Production of the Mesolongi salt lake

Station	April			October		
	GP	NP	R	GP	NP	R
1	0.0	0.0	0.0	-	-	-
2	188.7	40.4	146.8	-	-	-
3	165.4	57.4	106.6	308.3	8.3	297.0
4	100.5	100.5	0.0	39.9	8.5	25.1
5	352.2	119.9	299.9			
6	298.6	124.4	172.5	114.6	64.2	49.9
7	243.1	125.8	116.2	0.0	0.0	0.0
8	355.7	0.0	352.1	127.7	88.4	38.9
9	367.9	223.2	143.2	483.2	226.2	254.5
10	210.8	110.0	99.8	47.4	23.7	23.5
11	110.0	82.5	27.2	103.1	88.4	14.6
12	41.2	0.0	40.8	20.4	10.2	10.1
13	88.9	22.2	66.0	323.8	195.3	127.2
14	70.2	25.4	44.4	215.9	154.2	61.1
15	78.9	60.4	18.3	104.8	41.9	62.2
16	153.2	78.6	73.9	117.5	53.4	63.4

Results in mg C/m^3 per hr.

On the basis of ODUM's (1963) classification and considering the whole area as one ecosystem, the salt lake of Mesolongi is classified in the autotrophic ecosystems. Moreover, if the various groups of the evaporation ponds as described earlier are examined separately, it is noted again that each separate group forms an autotrophic ecosystem.

The measurement of the gross production in relation to the total incident radiation enables the classification of the corresponding to station 9 pond among the fertile ecosystems. The other stations show a satisfactory gross production.

It is generally concluded that the Mesolongi salt lake is a productive area.

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Fisheries of Lake Quarun, Egypt

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Lake Quarun is a desert lake located 180 km. west of Cairo. The isolation of the lake in the western desert resulted to various salinity levels from about fresh water (drainage water) to about 32 ppt in the open lake.
The sharp decrease of the annual catches was expected as a result of several influences; among which the uncontrolled transplantation of marine fish fry into the lake seems to be the most important. A total catch of about 3000 tons landed in 1971 dropped to about 500 tons during the last years.

Material and method

Monthly collections of water samples, fish eggs and larvae, data on fish catch and used gear were obtained for the period from June 1990 to September 1991.

Results and conclusion

During the period of sampling, salinity of lake water varied form 2.1 ppt near the openings of the drains to about 32 ppt in the open lake. The unusual increase in water salinity was due to the high level of evaporation which affected severely populations of different tilapias. The catch analysis revealed that *Tilapia zillii* was numerically dominant, making up the 1.4% of the catches. *Oreochromis aureus* amounted to 4.5% and the rest of 1.5% was shared between *Oreochromis niloticus* and *Sarotherodon galilaeus*.

Solea vulgaris caught by trammel net (operated on the lake bottom) constituted about 10% of the total annual catch of the lake amounting to 135 tons in 1989. The recorded catch was about six times higher in 1966 (863 tons).

Catches with trammel net, frequently used in the lake, included species such as anchovy (*Engraulis* sp.) with average length from 7 to 10 cm. and gobies (*Gobius niger*) with average length from 10 to 13 cm.

The seasonal study of fish eggs and larvae confirmed the successful completion of spawning of adult anchovies in the lake. Larvae of about 1.3 cm. total length appeared in the hauled samples. Neither larvae nor eggs of grey mullets were identified and hence the observations of WIMPNEY (1936) and EL-ZARKA (1963), according to which *Mugil capito* and *Mugil saliens* spawn in the lake were not confirmed (*Mugil* spp. are annually transplanted into the lake).

Fisheries of lake Quarun would be developed if the illigal fishing and uncontrolled transplantation of marine fishes was eliminated.

Other marine fishes such as the cartilagenous skate (*Rhinobatus* sp.), sea bass (*Morone labrax*) and sea bream (*Chrysopherus aurata*) which are hap-hazard transplanted with the fry of grey mullets, appeared as adult fish in the lake.

Other factors, such as shrimp fisheries and water salinity are considered to base a sound policy for the future development and management of the lake.

Correlations between hydrodynamical parameters and catches of migrating fry (Lake Fusaro, Naples)

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Lake Fusaro is located in the Gulf of Gaeta, the Tyrrhenian Sea, and its characteristics make it particularly suitable for aquaculture. Its hydrodynamics are strongly affected by the tidal activity of the open sea, whose maximum range in that area attains, at the time of syzygy, 30 cm; tidal currents are namely responsible for the water turnover in the lake, thanks to the connection with the Gulf of Gaeta provided by three channels, and in particular by the one in the middle, which definitely plays the most important role.

Among the species of fry migrating into the lake through those channels, the most common ones belong to the family of Mugilidi, namely to the genus *Liza aurata, Liza ramada, Liza saliens* and *Mugil cephalus*; none of them seems to be very much affected by the variations in temperature and salinity evidenced by our measurements.

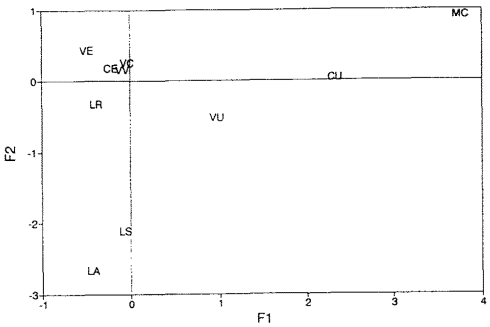
The main goal of this research is an investigation of the influence on the above mentioned species of a number of hydrodynamical factors, and in particular of the along-channel components of wind and current.

In order to assess correlations between catches and physical parameters we utilized the factor analysis of the correspondences, which represents one of the most recent methodologies within the field of ecological investigation.

Our study showed that catches of *Mugil cephalus* are correlated to well determined wind and current patterns, namely along-channel wind and flow regimes, while catches of *Liza aurata* and *Liza saliens* are more frequent in calm situations. Anyway, the tidal flow does not seem to affect them.

However, it has to be pointed out that the results of the statistical analysis are strongly affected by the still very little known behaviour of the fry fish, whose presence in the channels definitely depends upon the reproduction activity of the grown-up individuals, from the availability of food in the examined area, from the local meteorological conditions and, finally, from the intensity of the fishing activities along the domitian coasts.

Analysis of correspondances
Distribution of Variables



LA = *Liza aurata*	CU = Outgoing flow
LR = *Liza ramada*	VE = Incoming wind
LS = *Liza saliens*	VU = Outgoing wind
MC = *Mugil cephalus*	VC = Current speed
CE = Incoming flow	VV = Wind speed

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Water birds of the Lagoon in the Egion Area - N. Peloponnese, Greece

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Introduction

This report contains data concerning the status of water birds which were observed during 1989 in the lagoon area of "Aliki", Egion region, in the Northern Peloponnese. The lagoon has been protected by the local community since 1978 and belongs to one of the important bird areas in the European Community. There is a little information about the avifauna of this area and especially about the water birds which use the lagoon for breeding, as a stepping stone during the migration and as a preffered biotope for wintering. These were the main reasons which led us to study this wetland.

Site description - Methods - Climatic conditions.

The lagoon is situated almost in the centre of the Northern Peloponnese, 3 km east of the town of Egion. It is a small shallow lagoon with a surface of 18 Ha. The reed beds, helophytes, rushes and tamarisks constitute the flora of the lagoon and of the tidal zone, while orchards, olive groves and vineyards dominate in the cultural zone. We visited the lagoon from January - December 1989, on a monthly basis, 2-4 days at a time, while during April and September we visited the area twice a month. Simple 2 km transect lines were walked which passed through all the particular types of habitat within the area. The exceptionally dry conditions during 1989 in this region, were unfavourable to the water birds and had negative effects both upon the number of bird species and the number of populations which stayed in the area in order to breed.

Results and Discussion

Concerning seasonal occurence of avifauna we observed 54 water birds in total. (Table I). Eight of them are residents and occur all the year round. The rest are classified as follows: 23 sp. are passage migrants, of which 12 sp. of Charadriiformes stayed in the area during the summer in small numbers but did not nest; 7 sp. are summer visitors which came during spring; 12 sp. are winter visitors and 6 sp. are irregular visitors which can not be classified within any of the above categories because of insufficient data. In addition 33 bird sp. which have been recorded by scattered observations from Hellenic Ornithoological Society in the past were not observed by us. Among the residents, the most numerous were the Herring Gulls, Coots and Mallards, while the most numerous of the breeding summer visitors were the Little Ringed Plovers.

Concerning the pattern of seasonal occurence, during April we have a peak of 27 bird 5p. attributable to spring migration which started during the second week of March and continued until mid-June. This is not a rare pattern when exceptionally dry conditions dominate in winter and spring. Most of the bird species and the largest numbers of individuals passed through during March and April. A second peak of 29 bird species which were recorded in August is attributable on the one hand to some autumn migrants as the autumn passage has started and on the other hand to the summer visitors which have not yet begun their migration. Between mid-September and mid-October is a poor time in terms of bird sp. as most of the winter visitors have not arrived yet and most of the migrants and summer visitors have departed. February is the poorest month for the opposite reasons. Pintails, Teals and Pochards were the most numerous of the winter visitors.

E

Salt budget of Lake Burullus, Egypt

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With its location at the northern edge of the Nile Delta, Lake Burullus is the central one of the Egyptian Mediterranean system of coastal lagoons. It is a rather narrow (5-17 km) body of brackish water that occupies an area of about 350 km2 between Rosetta and Damietta branches of the Nile. The lake is very shallow (50-150 cm) and generally increases in depth towards the west and north. It is connected to the Mediterranean through, 200 m wide and 380 cm maximum depth, outlet known as El-Boghaz. Lake Burullus receives brackish drainage water via 6 drains (Fig. 1). The water and heat budget of the lake were studied by MAIYZA (1989) and MAIYZA *et al.* (1988 & 1991).

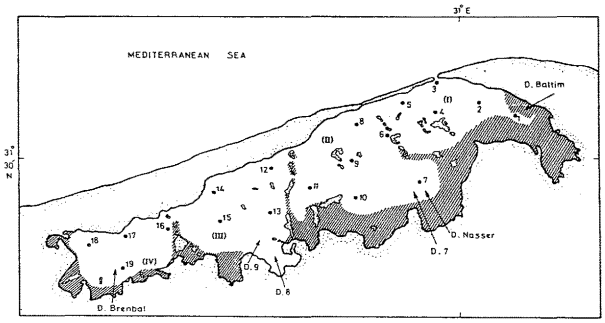

Fig. 1 : Present situation of Lake Burullus
D : Drain • : Hydrographic station

Salt budget is among the fundamental items of the hydrographic regime of a coastal lake. The present study aimed to disclose the state of salt budget and its controlling factors.

Within the period April 1987-March 1988, the monthly water temperature and salinity of different drains were determined. Meanwhile the monthly discharge of drain water was afforded by the record of the General Works and water Resources Directorate, Kafr El-Shikh Government. At Al-Boughaz, a RCM was moored monthly for about 4 days. From the records of the instrument (current, speed and direction, and water, temperature and salinity) and the crossection of the outlet, the salt exchange were estimated. The monthly salt content in the Lake were estimated also by summation of 19 zones represented by 19 monthly hydrographic stations. The salt content of a given water body was calculated as:

salt content = water volume * density * salinity.

Table 1 shows the monthly salt balance components and the net salt balance besides the monthly salt content of Lake Burullus. The net salt gain by Lake Burullus during the period of study was 30 x 10^3 ton, which may be consumed by seepage, through the bottom, and/or vegetation. The main controlling factors were the wind and amount of drainage water discharged to the Lake.

Table 1. Monthly salt balance components, the net salt balance and the salt content of Lake Burullus for the period April 1987-March 1988 (in 10^3 ton)

Month	Drains	Exchange	Net	Salt content
April 1987	343.8	-264.4	79.4	1163.9
May	366.6	257.2	623.8	1814.7
June	374.4	-1799.8	-1425.4	2094.7
July	575.9	1560.8	2136.7	807.0
August	635.2	-688.0	-52.8	1124.2
September	664.1	1727.8	2391.9	1088.2
October	608.0	424.2	1032.2	1092.4
November	403.0	73.9	476.9	1076.3
December	512.3	-3286.2	-2773.9	2133.2
January 1988	433.0	-1198.1	-765.1	1224.4
February	346.8	-1647.2	-1300.4	1729.1
March	325.8	-719.1	-393.3	1920.7
Sum	5588.9	-5558.9	30.0	
Mean	465.7	-463.2	2.5	1439.1

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Peuplements benthoniques dans des différents substrats d'une saline

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La Sardaigne méridionale est caractérisée par la présence des salines et d'étangs très intéressant du point de vue scientifique (STEFANI, 1962; MOCCI DEMARTIS, 1973; DE MARTIS *et al.*, 1992; De MIRANDA *et al.*, 1988).

Le "Stagno di Capoterra" (fig. 1), prés de Cagliari, est un étangs littoral de faible profondeur (0,5 m) et d'une surface d'environ 200 ha. Elle est divisée en secteurs alimentés artificiellement en eau de mer par pompage. Actuellement il est usé comme bassin de présalation par une industrie du sel et pour ça la salinité est très variable pendant l'année. Même les substrats sont différents, le fond étant formé soit de terre de remblai, soit de "bentonite" et soit naturel.

Les échantillons de benthos ont été prélevés mensuellement à partir du Juillet 1988 au Juin 1989. Les taxa présents sont les suivants: *Nematoda, Polychaeta, Ostracoda, Copepoda, Amphipoda, Isopoda, Diptera* (larves), *Gasteropoda, Lamellibranchia, Platelminta* (fig. 2).

D'après les dates des analyses, on peut voir que les populations trouvées changent selon le type du fond.

1) Le bassin avec le fond constitué en terre de remblai est résulté plus apprécié par les Crustacés et les Lamellibranches.

2) Les bassins avec substrat de bentonite ne montrent pas de différences significatives dans la composition des peuplements, alors que la densité varie.

3) Le bassin avec fond naturel est le plus riche en taxa mais avec une densité inférieure par rapport aux autres bassins.

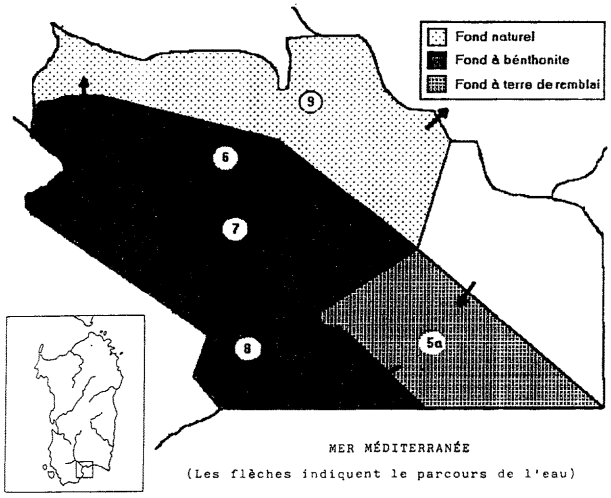

Fig.1. Stagno di Capoterra et stations d'échantillonage

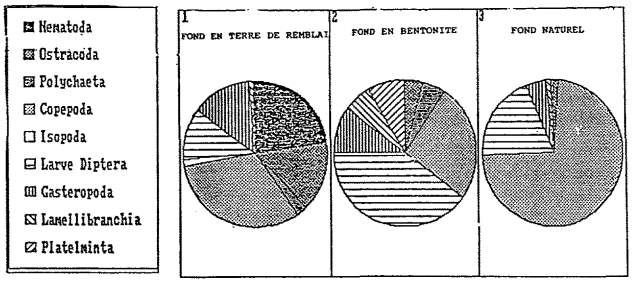

Fig. 2.

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Formation of modern dolomites in a Coastal Hypersaline Pool at Alamain, Egypt

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The studied pool is a part of a coastal system comprising a series of carbonate dune ridges and interdunal sabkha- lagoonal enviroments. This system was ascribed by many workers to various marine transgressive episodes of the Pleistocene. However, recently ALEXANDERSSON (1990) gave an age of 2100 years before present to the weekly cemented oolites of the coastal ridge.

The hypersaline pool occupies a small semicircular depression behind the coastal ridge. Seawater probably began to accumulate in this depression since 2000-4000 years ago during the last phase of marine transgression. The elevations of the coastal ridge in the study area vary between 2-7 meters. The occurrence of small stream-like channels on the lee side of the ridge lower sections may indicate that seawater could overtop the ridge during storm surges. Yet, the proposed mechanism of lagoon water replenishment is thought to proceed by seepage through the porous matrix of the ridge to replace the amount of evaporated water.

The water depth ranges from few centimeters at the peripheries to about 1.5 meters in the central part of the lagoon. The salinity of water as measured in the late spring was 78 per thousand.

This work is based on the study of 5 representative sediment cores varying in length from 70 to 180 cm. The bulk mineralogical composition was studied principally by X-ray diffraction with the help of DTA when necessary. The organic carbon and carbonate contents were also determined.

On the average the sediment matrix comprise 38% quartz, 8% feldspars , 16% calcite , 15% aragonite, 15% dolomite , 3% Mg-calcite, and occassional occurences of colestine, glauberite, anhydrite , bassanite, thenardite , huntite, nahcolite and strontianite.

The precipitation of calcite and aragonite throughout the whole sequence indicates that the solution has always been Ca-rich and has been subjected to moderate degrees of evaporation, yet never been desiccated. The promotion of calcite and aragonite deposition raises the Mg level in solution and hence the Mg/Ca ratio. This combined with the low sulphate level and high alkalinity-pH conditions resulting from active sulfate reduction (BAKER and KASTERN, 1981) favors dolomite deposition. The preservation of organic matter even at the deepest core intervals suggests the predominance of low redox environments at the sediment solution boundary throughout the whole depositional history.

The dolomite diffraction pattern always showed a sharp 104 reflection with at least 4 other reflections. Some samples gave reflections of typical dolomite (d_{104} = 2.886 A°), but in many cases the 104 peak is slightly displaced to higher 20 angels. Evidence from DTA analysis proved that the shift in the peak position was due to substitution of iron for Mg. In fact the presence sometimes of a faint split peak may suggest a physical mixture of Fe-dolomite and normal dolomite.

The variability in the quantity and, perhaps, the type of dolomite with depth intervals in cores may reflect episodic fluctuations in the physico-chemical properties of the precipitating solution, rather than diagenetic reactions. However, the mineral suite indicates that such fluctuations were slight and limited in exent as proved from the rare and occasional occurences of accessory minerals and the continuous deposition of the principal mineral association.

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Zooplankton of the meromictic coastal Lagoon of Cullera (Spain)

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The lagoon at Cullera, on the Spanish mediterranean coast (RODRIGO *et al.*, 1992), had, in 1980-81, a permanent sea water wedge, that caused a strong stratification of the water, with a steep gradient of salinity and the presence of an anoxic water layer (fig. 1). The result was a vertical and horizontal heterogeneity of physicochemical parameters and zooplankton (MIRACLE and VICENTE, 1983; MIRACLE *et al.*, 1988).
Samples were taken bimonthly during the period of august 1980 to october 1981, from the vertical profile and from three different sampling points, at the mouth (1), the center (2) and source of the lagoon (3) (fig. 1).

Freshwater zooplankton dominated in the lagoon, and only in autumn-winter the presence of some marine/brackish water species was observed. Generally, copepods and rotifers were more abundant in samples from point 3, less influenced by sea water intrusion, and cladocerans were more abundant in samples from point 2.
Table 1 shows the more abundant species of zooplankton. In addition to these species, another 9 species of copepodes, 5 species of cladocerans, 20 species of rotiferes, nauplii of cirripeda, ostracodes, nematodes and protozoans (Rhizopodea) were found. The presence of marine copepodes (*Acartia clausi, Acartia grani, Oithona nana*) and parasites of fish (*Ergasillus sieboldi*) were noticed.

Zooplankton was dominated by the permanent copepods *Calanipeda aquae-dulcis, Acanthocyclops robustus* and *Metacyclops minutus* (in spring), the cladoceran *Moina micrura* (in summer) and rotifers of the genus *Brachionus, Hexarthra, Notholca, Synchaeta* and *Polyarthra*. The larvae of the polichaete *Mercierella enigmatica* and ciliates of the genus *Euplotes*, were also abundant during spring and autumn (table 1).
Some of these species, i. e., *Hexarthra fennica, Notholca salina, Synchaeta tremula* and *Synchaeta grimpei*, are located in the oxic-anoxic boundary where they show high population densities.

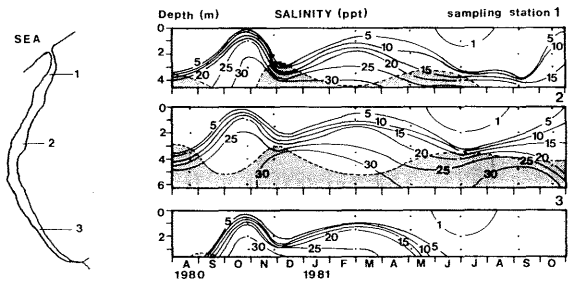

Fig. 1.- Salinity isopleths in Cullera lagoon at 3 sampling stations located as shown in the outline on the left. The anoxic water layer is shaded.

Table 1.- Most abundant zooplankton species of Cullera lagoon (occurrence > 10 % of samples), with indication of their maximum density, as well as the seasons (Sp, spring, Sm summer, A, autumn, W, winter,) and the sampling stations (1, 2, 3) where this maximum was reached. Also values of temperature, conductivity and pH corresponding to each species maximum density are indicated.

Especies	Seasons of maximum	Sampling station$_{max}$	Density$_{max}$ (ind l^{-1})	T™ (°C)	Conduct. (mS cm^{-2})	pH
Copepodes						
Calanipeda aquae-dulcis	Sm, A	2	314.0	19.0-23.0	6.3-47.0	7.0-7.8
Acanthocyclops robustus	Sm	3	380.7	22.5-25.5	1.1-4.5	7.4-7.9
Metacyclops minutus	Sp	3	22.7	16.9-22.2	1.7-30.7	7.5-8.2
Ergasillus sieboldi	A	2	1.4	23.0	26.0	5.0-8.7*
Cladocerans						
Moina micrura	Sm	2	72.9	26.0-30.0	2.0-8.8	7.7-8.6
Rotifers						
Brachionus plicatilis	A	3	1043.0	19.0-22.0	6.3-47.6	7.0-7.8
Brachionus calyciflorus	Sm	2	764.7	30.0	2.0	8.6
Brachionus angularis	Sm	2	145.7	25.0	1.6-40.5	6.9-8.6*
Brachionus urceolaris	A	2	17.5	22.5	6.6-26.5	4.8-8.7*
B. quadridentatus	Sp	2	5.2	20.0	2.0	6.0
Brachionus leydigi	W	2	0.2	14.0-14.5*	3.1-12.5*	7.6-8.6*
Keratella tropica	Sm	2	7.6	30.0	2.0	8.6
Keratella cochlearis	Sp	3	1.6	16.9-22.2	1.7-30.7	7.5-8.2
Keratella quadrata	Sm, A	3	0.7	8.0-26.0*	1.1-49.0*	6.9-8.6*
Notholca salina	A	3	47.3	9.0-18.0	1.3-45.6	7.1-8.4
Notholca marina	A	1	4.7	8.0-16.0	2.2-45.2	7.9-8.5
Euclanis dilatata	Sp,Sm	3	3.5	16.9-22.2	1.7-30.7	7.5-8.2
Mitilina ventralis	Sm	3	0.7	22.5-25.5	1.1-43.0*	7.4-7.9
Lophocharis salpina	A	3	9.0	9.0-18.0	1.3-45.6	7.1-8.4
Trichotria tetractis	Sm	2	1.0	25.5-26.0	1.2-4.0	7.4-7.8
Colurella adriatica	A	3	0.7	9.0-10.5	1.4-49.0*	8.4
Lepadella ovalis	Sm, A	3	2.2	26.0	1.1-47.8*	7.8-7.9
Lepadella rhomboides	Sm	3	1.2	16.0-26.0*	1.1-47.3*	7.8-7.9
Lecane luna	Sm	2	0.7	23.0-25.8	1.1-49.6*	4.7-8.7*
Lecane ungulata	A	3	5.5	9.0-18.0	1.3-45.6	7.1-8.4
Lecane hastata	Sm	3	1.5	22.5-25.5	1.1-4.5	7.4-7.9
Lecane bulla	Sm	2	1.5	22.5-25.5	1.1-4.5	7.4-7.9
Lecane closterocerca	Sm, A	3	2.0	9.0-10.5	1.3-11.0	8.4
Lecane hamata	Sm	3	1.7	26.0	1.1-1.2	7.8-7.9
Trichocerca elongata	Sm	3	3.0	26.0	1.1-1.2	7.8-7.9
Asplanchna brightwelli	Sm	2	19.2	30.0	2.0	8.6
Synchaeta tremula	A	2	872.3	20.0-23.0	12.1-29.4	5.0-8.7*
Synchaeta oblonga	Sp	1	188.7	18.0	21.6	7.6
Synchaeta pectinata	Sp	3	5.3	16.9	30.7	7.5
Synchaeta grimpei	W	2	235.2	13.0-14.0	41.9-52.0	7.3
Polyarthra vulgaris	Sm	2	167.3	23.0-25.8	1.3-40.5	5.0-8.7*
Hexarthra oxyuris-fennica	Sm, A	2	689.0	20.0-23.0	12.1-42.4	6.9-8.6*
Polichaeta larvae						
Mercierella enigmatica	Sp, A	2	268.2	22.5-23.0	26.0-29.4	7.5
Ciliophora	A	3	1656.0	7.9-26.2*	1.1-52.7*	4.7-8.7*

* Range corresponding to the presence of the species, because the species had not a marked maximum or the parameter was not measured at the species maximum.

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Relationship between the physico-chemical parameters and the macrobenthic fauna in the soft substratum of the Homa Fisheries Lagoon

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Homa fisheries lagoon is located between the Gediz River and the Çamalti Salthern (Fig. 1). Its consists in two basins: the basic fisheries lagoon (7 Km long, 5 Km wide and 1200 Ha surface) and a smaller and shallower basin (3.4 Km long, 1.2 Km wide and 300 Ha surface).

This investigation was carried out in the basic fisheries lagoon which has a maximum depth of 0.8 m and a mean depth between 0.4-0.5 m. There are three gates which connect the lagoon to the sea, but only one of them is working now.

Physicochemical data and benthonic samples have been taken at 5 stations seasonaly (January, March, July and September) during three years, 1989-1991. The following parameters were measured: temperature and salinity (portable thermometer, Mohr-Knudsen method), pH (Varila pHmeter) and dissolved oxygen (Winkler method).

Sediment samples were taken by means of a Van Veen Grap that can hold 3.3 l of sediments. For each sampling date and station, 10 l of sediments were collected. Organisms were separated by sieving through a 2 mm mesh and fixed with 10 % formaldehyde. The results of the study of the benthonic samples are shown in Tables 1 and 2.

Table 1. Total number of individuals and species for each sampling station found in the 12 samples taken during 1989-91.

Stations	N°species	N°individuals
1	22	2630
2	20	3747
3	15	6570
4	16	5888
5	14	5071

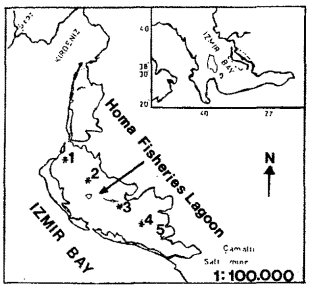

Figure 1. Sampling stations.

The ranges of the measured physico-chemical parameters were: temperature 5-26 °C (Fig. 2, A), salinity 34.51-73.54 ppt (Fig. 2, B), pH 6.94-8.40 (Fig. 2, C), dissolved oxygen 4.4-11.6 mg·l^{-1} (Fig. 2, D).

At the end of the studies, maximum salinity 73.54 ppt and minimum dissolved oxygen 4.4 mg·l^{-1} have been found. The numbers of species and individuals change depending on the station and season. Some species number decrease, some species number increase (*Abra pellucida, Chrinomus* sp.) especially in the summer months. In addition, we observed the blooms of *Lyngbya macuscuta*.

Table 2. Total number of species and individuals found for each taxonomic group in Homa fisheries lagoon.

Tax. Groups	N species	N individuals
Polychaeta	13	204
Mollusca	7	11364
Crustacea	9	908
Diptera (Larvae)	1	11438
Total	**30**	**23914**

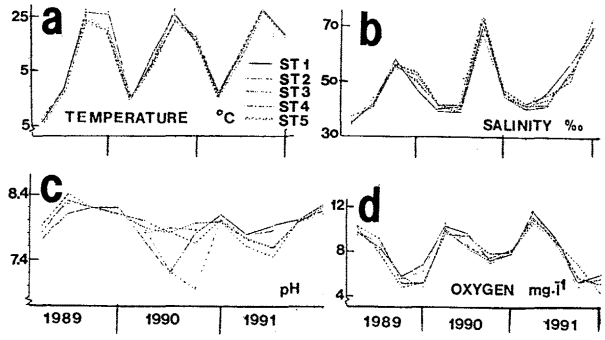

Figure 2. Physico-chemical parameters in Homa fisheries lagoon

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Colonization rates and dispersal as essential parameters in the confinement theory to explain the structure and horizontal zonation of lagoon benthic assemblages

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In place of parameters such as salinity, ionic composition, etc., the confinement theory proposes renovation-rates of vital elements in marine water as the main factor to explain the composition and structure of benthic assemblages and the observed gradients in population-density, biomass, specific richness, and diversity, in coastal lagoons (GUELORGET & PERTHUISOT, 1983).

However, this model is not altogether free from difficulties. Data cited in the bibliography, and the results of our work at the Mar Menor lagoon (SE Spain) (PEREZRUZAFA, 1989), show that the distribution of some communities and macrophytic meadows, like those *Caulerpa prolifera, Ruppia cirrhosa*, etc., display patch-distributions, related to the nature of the bottom, physical and chemical composition of sediments, minimum temperatures, wave-energy or hydrodynamism, and depth, instead of horizontal gradients. These species can inhabit zones other than those predicted by the model of GUELORGET & PERTHUISOT (1983). Furthermore, some assemblages, of fishes and other vagile macroinvertebrates, do not respond to the predicted gradients, and recent colonizers show temporary gradients in horizontal zonation.

We propose that lagoon zonation and community structure must be considered in terms of a new conceptual model. This includes a multifactorial approach in which lagoon-assemblages composition is related, on the one hand, to reproduction and growth-rates as result of adaptations and energetic costs to physical and chemical factors, and, on the other, to the confinement concept reinterpreted as the capability of open-sea organisms to colonize the paralic environments. In this way, interspecific competition between colonizers and paralic species can be one of the essential factors determining community structure. In resolving equations of competition, population growth-rates also include colonization or effective settlement rates. Thus, disadvantages in competition can be compensated for if immigration rates are high enough, so that competitive equilibrium is permitted. This would explain the higher diversities observed near the channels of communication with the open sea and the different patterns shown by sessile and vagile fauna.

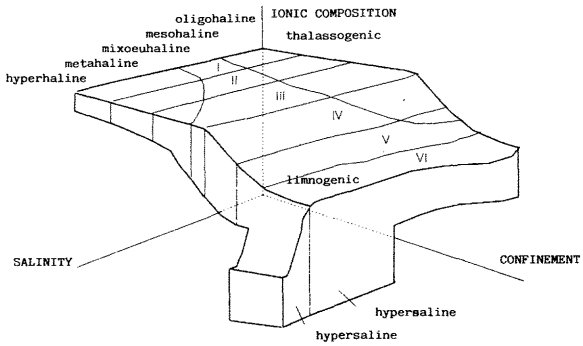

Fig. 1 - Body water and biological zonation classification according to some of the main factors that determine them.

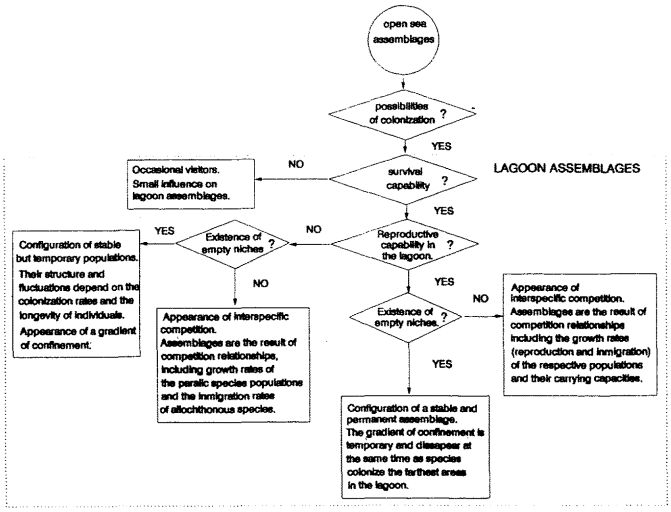

Fig. 2 - Conceptual model to explain the structure of lagoon benthic assemblages.

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The unusual nature of the water supplying a coastal wetland (La Albufereta de Pollença, Mallorca, Balearic Islands)

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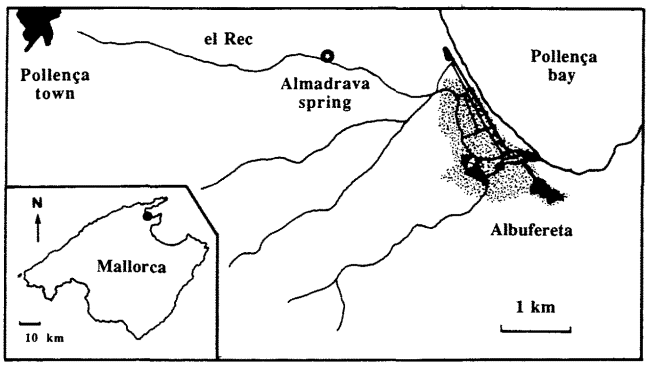
La Albufereta de Pollença is a wetland coastal zone located in the North of Mallorca (see figure). It is separated from the sea by a narrow (50-100 m) belt of dunes which is traversed by a road (12 m wide). By area (approximately 150 Ha), La Albufereta is the second largest wetland of the island. In common both with the most Mediterranean coastal wetlands, the zone experience constant environmental pressures (VELEZ, 1979).

Three main areas may be distinguished in La Albufereta: small shallow lakes, channels which are mostly artificial and a vegetated zone (represented mostly by the *Phragmition australis* and *Arthrocnemion fruticosi* alliance). General characteristics of the zone (including flora, fauna and human influence) are described by CERDA *et al.*, (1986).



The most distinctive feature is the contribution made by water, mostly by "torrentes" (temporal streams) as in the rest of the island. The average annual volume of water which flows through the zone amounts to some 24 Hm^3; although the Torrente el Rec with less than a third part of the catchment area, alone supplies around 75% of the total inflow. This is due to a spring (Almadrava) which contributes 17 Hm^3 annually, the outflow from which varies from 20 and 30 l s^{-1} during the summer months to a maximum of 5 m^3 s^{-1} (SERVEI HIDRAULIC, 1987). The continual presence of water throughout the year in el Rec between Almadrava and La Albufereta means that it is covered almost thoughout its whole length by macrophytes: *Potamogeton pectinatus, Zanichellia palustris, Zanichellia palustris* var. *gramen, Ruppia maritima, Enteromorpha intestinalis, Chaetomorpha capilaris, Ulva curvata* and *Cladophora* sp. are the most prominent species.

From 1987, samples of the torrent water have been taken at irregular intervals from between the environs of Pollença to La Albufereta. The monitoring of the chemical parameters has been carried out using standard methods (GOLTERMAN *et al.*,1978; APHA, 1981). Maximum, average and minimum values for ten locations between Almadrava and La Albufereta (A), and for four locations between Pollença and Almadrava spring (B) are presented in the table.

	A			B		
pH	8.11	7.27	6.55	8.25	7.80	6.59
CONDUCTIVITY ($mS\ cm^{-1}{}_{20°}$)	20.00	10.82	2.00	5.52	1.35	0.72
ALKALINITY ($meq\ l^{-1}$)	6.70	3.63	0.60	12.60	5.15	1.45
CHLORIDE ($g\ l^{-1}$)	9.33	3.73	0.82	0.18	0.12	0.04
SULPHATE ($mg\ l^{-1}$)	978.50	635.83	273.90	224.63	97.07	52.21
CALCIUM ($mg.l^{-1}$)	400.00	277.05	160.00	232.00	156.00	72.00
MAGNESIUM ($mg\ l^{-1}$)	447.00	220.20	72.90	38.80	12.29	4.86
PHOSPHATES ($\mu g\text{-at}\ l^{-1}$)	2.53	0.62	0	165.74	83.32	8.81
SILICATES ($\mu g\text{-at}\ l^{-1}$)	154.17	82.38	32.29	289.58	152.78	38.40

In group B most of the samples are from water left in hollows in el Rec since there is only occasional water flow. The results show the water to be fresh with high phosphate content, reflecting human influences. The major alkalinity variations result from either production or consumption of oxygen which depends on the sample point locations and time of the year.

The Torrente el Rec water from La Almadrava (A) is supplied by the spring and is brackish. It has a high chloride, sulphate and magnesium concentration. Although the aquifer supplying the spring is still not properly understood (SERVEI HIDRAULIC, 1987), the absence of gypsum in the rocks of the catchment and the continuity of flow of the spring throughout the year suggests a clear marine influence.

La Almadrava spring, due both to its outflow volume and its chemical make up, is unusual and unique in Mallorca.

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Inestability of the meromixis in the Coastal Lagoon of Cullera

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The variation of some limnological parameters in the lagoon of Cullera (Spain), an elongated coastal lagoon with estuarine water circulation (Fig. 1), was studied during the annual cycle of 1987. Although the lagoon showed a sharp picnocline during the whole year, which oscillated between 1 and 2 m of depth depending on the interactions between sea and freshwater, an oxycline was only present from May to October (Fig. 2, C). In this period vertical gradients of light, sulfide, conductivity and nutrients determined the presence of dense populations of green phototrophic bacteria, mainly *Chlorobium phaeovibriodes*, which developped a plate located around 2 m of depth Its density distribution along the year is shown by the isopleths of bacteriochlorophyll *e* (Fig. 2, D).

This lagoon, as many others coastal lagoons, is subjected to great fluctuations, thus the annual cycle of 1987 was very different from that recorded some years ago (MIRACLE and VICENTE, 1985; ROJO and MIRACLE, 1989). In 1980, this lagoon was described as showing ectogenic meromixis, because it had a permanent sea water wedge, that only disappeared after the flood which took place in autumn 1982. During those years a steep picnocline divided two water layers: a flowing oligohaline water layer above a saline anoxic layer. Because of the destruction of the sand bar in that flood, the lagoon did not show more a permanent meromixis and was like an estuary. In this study the halocline is much more superficial and the lagoon has a strong marine influence. This influence causes the oxygenation of the deepest waters, reaching progresively more superficial waters towards the oxycline arriving to contact with the epilimnetic oxygenated waters. This fact together with the effect of a new flood which occured in November 1987 disturbed completely the summer column structure and the phototrophic bacteria population totally disappeared after this date.

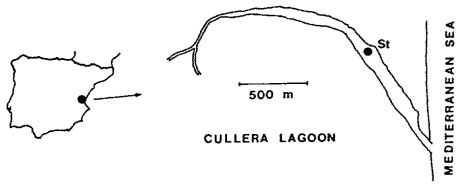

Figure 1. Geographical situation and outline of Cullera lagoon. St: Sampling station.

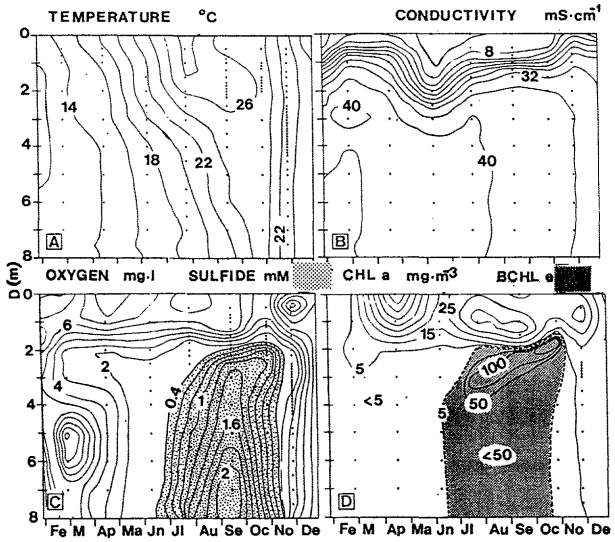

Figure 2. Isopleths representing depth and temporal distributions of some limnological parameters in the lagoon of Cullera. **A**: Temperature; **B**: Conductivity; **C**: Oxygen and sulphide; **D**: Algal chlorophyll *a* and bacteriochlorophyll *e* from *Chlorobium phaeovibriodes*.

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E

Further Limnological investigations on Lake Edku, Egypt

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Studies of some limnological conditions in Lake Edku, an Egyptian shallow brackish-water lake connected to the Mediterranean Sea, were carried out during 1989 and are compared to published data from the last decades.

Lake Edku, a shallow brackish-water basin connected to the Mediterranean Sea via a narrow channel, has an area of 115 Km^2 and a depth ranging from 0.5-1.5 m. The main water supply comes from three main drains. Their total discharge during 1989, ranging from 43.8-119.7 x 10^6 m^3, was higher than that reported by NASR *et al.* (1963), but lower than that stated by SAAD (1976). Such fluctuations in the drainage water supply affected markedly the hydrography and chemistry of the lake. Field measurements and water sampling were carried out monthly during January-December 1989 at 15 selected stations.

In lake Edku, being shallow, no thermal stratification was observed. The monthly averages, ranging from 11.9°C in January to 28.6°C in August, suggest insignificant variations with previous readings during 1969-70, ranging from 14.5-28.5°C also in January and August, respectively (SAAD, 1976).

Transparency varied widely from 0.2-1.5 m. The values showed pronounced local and seasonal variations, with annual mean of 0.53 m. The minimum regional average value of 0.31 m at the lake-sea connection reflects the increase in turbidity from stirring up of the bottom material by the lake-sea and sea-lake currents, as well as from the entering suspended load in sewage and industrial wastes from the adjacent Abu-Kir Bay. The decrease in monthly average Secchi readings during April to September suggests the increase in turbidity mainly from phytoplankton abundance in spring and summer. However, the increase in turbidity, especially in winter, reflects the effect of prevailing wind in stirring up the bottom sediments (SAAD, 1978).

The pH was always found on the alkaline side, ranging from 7.11-10.27, with an annual mean of 8.42. The pH values found in the same lake by SALAH (1947) varied from 8.0-8.8, by NASR *et al.* (1963) from 7.5-9.0 and by SAAD (1976) from 7.63-9.50. This confirms that the pH of Lake Edku has been changed in the last decades.

The spatial average pH values varied slightly from 7.97-8.96 and the locations directly influenced by drainage water discharge gave the lowest values. SAAD (1976) also reported the same condition. However, the highest pH values were found at locations densely populated by macrophytes. The monthly averages varied slightly from 7.83 in October to 8.87 in May. Photosynthetic activity is among the main factors controlling the seasonal variations of pH (SAAD, 1976).

Dissolved oxygen (DO) varied markedly from 1.14-12.93 $ml.l^{-1}$, with an annual mean of 5.3 $ml.l^{-1}$. The highest DO values were found at locations affected by water mixing and the lowest at areas densely populated by macrophytes and near the drainage water discharge. The highest DO averages in winter coincided with increased aeration by strong wind, low temperature and the decrease in the rate of DO consumption by organic matter decomposition. The low DO averages in spring and summer suggest that the rate of DO consumption exceeded that of its supply from phytoplankton.

Chlorosity varied considerably according to localities and seasons (NASR *et al.*, 1963). The values found by SAAD (1976) varied from 0.44-23.24 $g.l^{-1}$ compared with the present values ranging from 0.47-7.88 $g.l^{-1}$. The spatial averages varied noticeably from 0.71-2.27 $g.l^{-1}$, with an annual mean of 1.20 $g.l^{-1}$ which is markedly lower than that of 2.92 $g.l^{-1}$ found by SAAD (1976). The locations directly affected by drainage water discharge gave the lowest chlorosity averages. Thus, distribution of chlorosity in Lake Edku is mainly controlled by the influx of drainage water and the inrush of sea water (SAAD, 1976). The range of monthly averages, from 0.77-2.0 $g.l^{-1}$ differs markedly from that found by SAAD (1976), ranging from 0.69-10.41.

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Comparative study of metalic ions penetration and bioaccumulation in *Tilapia zilli* Gerv living in fresh and saline water (30‰)

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Laboratory experiments for investigation differential penetration and bioaccumulation of calcium ($Ca^{45}Cl_2$) as macroelement, iron ($Fe^{55}Cl_2$) as microelement, and mercury ($Hg^{203}Cl_2$) as inorganic pollutant in the euryhaline fish *Tilapia zilli* Gerv living in fresh and saline water (30‰) aquaria containing the previous mentioned isotopes for 40 days showed that the permeability of $^{45}Ca^{++}$ is 20% and 8% respectively for fresh and saline water, and its accumulation factors (AF) in the different organs and tissues of the fish are ones or tens except in the skin which is higher. While that of $^{55}Fe^{++}$ is 37.5% and 25% respectively for the permeability, and its accumulation factors (AF) are tens or hundreds. On the other hand, the permeability of $^{203}Hg^{++}$ is nearly complete and its accumulation factors (AF) are hundreds or thousands (Table 1).

It was noticed also that the bioaccumulation of $^{203}Hg^{++}$ is maximum in the kindey which probably means that the chronic toxicity of mercury is mainly due to its destruction of the fish kindey, as mercury reacts with its components rich in Ca, P and S (LEESON and LEESON, 1970). The bioaccumulation of $^{55}Fe^{++}$ is maximum in the liver and intestine which probably causes its chronic toxicity due to alternation in the liver structure which could be noticed in swelling of its cells, its blood vessels are extremely congested and lobular liver structure is largely disappeared (SALEH and HAMZA, 1986). KOHLER and HALZEL (1980) demonstrated that the pollution of aquatic environment with heavy metals causes highly damage in the intestine of the fish as the submucosa is unfiltered occasionally with lymphocytes and small intestine vessels are congested. The architecture of the villi is largely destroyed and the intestinal epithelium has disappeared and bleeding.

The bioaccumulation $^{45}Ca^{++}$ is maximum in the caudal fin "skin" which means that the fish absorbs calcium directly from the surrounding water through its skin to regulate metabolic rate as calcium role in decreasing permeability of the skin to elements and ions is well known (Table 1).

However, the permeability of elements and ions, their accumulation factors (AF), and their bioaccumulations in organs and tissues of *Tilapia zilli* living in fresh water aquaria are higher than those of the fish living in saline water aquaria due to the tendency of the fresh water fish to absorb more elements and ions to avoid hypotonism.

Tab. 1.- Bioaccumulations (B) of $^{45}Ca^{++}$, $^{55}Fe^{++}$ and $^{203}Hg^{++}$ as impulses/minute x gram organ or tissue of *Tilapia zilli* living in fresh or saline water (30 ppt) aquaria. Their accumulation factors (AF) and their contents in the aquarium water, as impulses/minute x ml, are also indicated.

Organs	Fresh water aquaria						Saline water aquaria					
	$^{45}Ca^{++}$		$^{55}Fe^{++}$		$^{203}Hg^{++}$		$^{45}Ca^{++}$		$^{55}Fe^{++}$		$^{203}Hg^{++}$	
	B	AF	B	AF	B	AF	B	AF	B	AF	B	AF
Kidney	3900	11,5	182	18,2	30850	15425	1860	4,6	109	9	15270	6108
Liver	555	1,5	1122	112,2	10910	5455	460	1,1	209	17,4	5540	2216
Intestine	8900	26	5960	596	3270	1635	580	1,6	1850	154	5820	2324
Gills	5890	17,5	51	5,1	1874	935	410	1	41	3,4	1400	500
Caudal fin	6440	191	51	5,1	380	190	3230	8	40	3,3	550	220
Gonads M	1220	3,6	250	25	3010	1505	880	2	200	17	620	248
Gonads F	630	1,9	110	11	560	280	70	0,2	65	5,4	90	36
Fish flesh	765	2,2	5,6	0,58	145	77,5	37	0,12	4,2	0,35	110	44
Water aquarium	Start	436		16		72		439		16		72
	Final	339		10		2		402		12		2,5

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Populations phytoplanctoniques et successions écologiques dans une Lagune saumâtre : le Lac El-Mellah (Algérie)

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Le lac El-Mellah, au nord de l'Algérie est une lagune saumâtre de 865 ha de superficie qui reçoit plusieurs cours d'eau et qui communique avec la mer par un chenal étroit (fig 1). La profondeur maximale est de 5 mètres. Ce plan d'eau a fait l'objet d'un interêt scientifique soutenu (1,3) et d'un interêt économique puisqu'il est exploité à des fins d'élevage aquicole.

A partir de déterminations et de numérations phytoplanctoniques réalisées de février 1991 à juin 1991 nous avons essayé de décrire l'évolution et le fonctionnement à l'échelon primaire de l'écosystème du lac.

L'inventaire floristique a montré des espèces franchement marines, des espèces saumâtres et des espèces dulçalicoles.

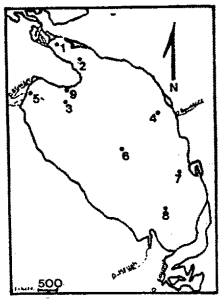

Fig (1) Localisation des stations

Les dinoflagellés déjà signalés dans ce plan d'eau (1,3) sont présents tout au long de la periode d'étude. Parmi eux nous avons relevé des espèces potentiellement toxiques telles que *Dinophysis acuminata*, certains *Gonyaulax* ou *Gyrodinium*. La comparaison des proportions par groupe montre une prépondérence des flagellés verts.

Après avoir décrit les successions écologiques au moyen de DRF de FRONTIER (2) au niveau de chaque station (tableau 1), nous tentons d'esquisser un schéma d'évolution de la succession pour l'ensemble du lac. On peut décrire globalment pour le lac deux successions.

L'une hivernale qui atteint son stade d'équilibre en février et l'autre qui démarre en mars à la suite des effets conjugués des apports nutritifs des mois précédents et de l'élevation de température. Cette dernière succession se poursuit jusqu'en été.

Il y aurait en quelque sorte une grande succession pour l'ensemble de la masse d'eau que TRAVERS (4) dénomme succession primaire et, au niveau de l'une ou de l'autre station des successions secondaires qui peuvent évoluer plus rapidement ou bien avorter en cours d'évolution.

Tableau 1. **Successions écologiques par station surface (S) et fond (F) et par mois.**

STATION	1		2		3		4		5		6		7		8		9
MOIS	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F	
FEV			2		2	2	2	2	2	2	2	2	3	3	2	2	
MAR	2	2	1	1	1		1	2	3	1	3	1	1	1	3	1	2
AVR	3	3	3	1	1	1	2	3	3	1	3	1	1	2	1	2	1
MAI	1	2	1	1	1	3	2	2	1	1	1	3	2	2	3	1	3
JUN	1	1	3	2		2	3	2	2	2	3	1	2	2	3	2	2

Ainsi la station 1, la plus "marine", semble avoir une évolution particulière. La succession semble y être decalée d'un stade par rapport au reste de la masse d'eau. Dans les stations 3, 4, 5 et 6 dites de l'ombilic hydraulique (3) le stade 1 revient très fréquemment. Par contre, dans la zone de confinement (stations 7 et 8) où les eaux marines entrantes s'accumulent, les stades 2 et 3 sont très fréquents. Les démarrages de successions localisés dans certaines stations correspondent à des événements locaux déterminés par des phénomènes hydrologiques, en particulier les courants et les apports continentaux qui créent des stress d'enrichissement et des zones de mélange favorables aux déclenchements de nouvelles successions. Ces stress physiques ou chimiques qui interrompent la succession principale représentent autant de déséquilibres ponctuels dans cet écosystème confiné et en cours d'eutrophisation.

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Trace metals in sediment cores from Santa Giusta Lagoon (Sardinia, Italy)

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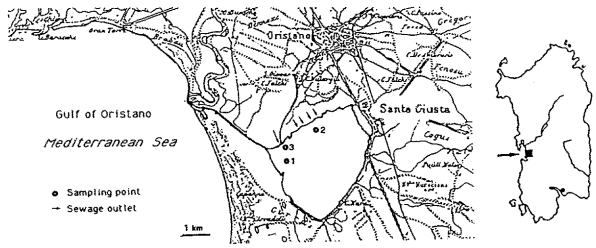
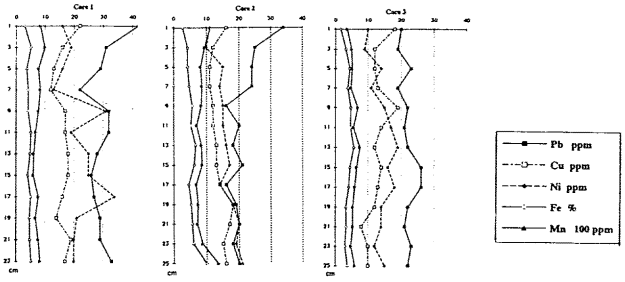
The Santa Giusta lagoon, on the western coast of Sardinia, in the Gulf of Oristano, is the third largest coastal lagoon of Sardinia (830 ha). In the 60's the lagoon was among the most productive fisheries in Europe (850 kg/ha). However, the increasing discharge of raw sewage from Oristano and Santa Giusta (about 40.000 inhabitants), agricultural runoff and reduced water circulation considerably lowered the water quality and the fish production. Moreover the lagoon suffers from a large development of *Ficopomatus enigmaticus* banks and from occasional microalgae blooms, along with anoxic conditions - in the ultimate years, several massive fish death occurred. No major industrial development is present in the area.

In October 1991 sediment cores were taken from three sites (cf. Fig.): in front of a canal linking the lagoon with the sea, built in 1952 to improve the water renewal (K1); in the area exposed to waste discharge from a series of small canals (K2); at the outlet of the S. Giovanni canal, which carries untreated wastewaters from Oristano (K3). The frozen cores were sliced into 1 cm (superficial sediment) and 2 cm sections and air dried. Subsamples were ground in an agate mortar, sieved, and the fraction < 75 µm was collected for the analysis. Metals were extracted with a mixture of concentrated HN03 and HCl (90:10) (SCHINTU *et al.*, 1991). Lead, Cd, Cu, Ni, Fe and Mn were determined by atomic absorption spectrophotometry. Organic carbon was determined by digesting the sediments with H_3PO_4 and 0.1 N $K_2Cr_2O_7$ in H_2SO_4, and back-titrating the excess with 0.25 N $FeSO_4$.

Cadmium concentrations were always below the detection limit of the method (0.1 µg/g d.w.). The mean organic carbon concentration in the cores (C%) was: K1 1,69%; K2 1,09%; K3 0,96%. Lead, Ni, Cu, and organic carbon concentrations in core K1 were higher than in cores K2 and K3. Metals are probably associated with the organic matter, which is an excellent scavenger for a large number of them. In cores K2 and K3 metal concentration profiles show comparable tendencies and the concentration of all metals but Pb does not vary significantly as a function of depth. While the sediments present low concentrations of these metals, even when compared to other sardinian lagoons and coastal areas exposed to sewage discharge (CONTU *et al.*, 1983; SCHINTU *et al.*, 1991), the increase of the Pb concentration in the upper profile of the cores K1 and K2 suggests a growing input of this metal in the lagoon throughout the last years.





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E

Caractéristiques méristiques et métriques de trois populations d'Athérines des Côtes françaises

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De nombreux auteurs dont KIENER et SPILMANN, 1969, 1972; TRABELSI,1989; KARTAS et TRABELSI, 1990 ont montré que l'espèce *Atherina boyeri* (Risso, 1810) ne formait pas un ensemble morphologiquement homogène dans son aire de distribution.

Afin de contribuer à la connaissance du polymorphisme chez cette espèce, nous avons effectué des observations biométriques sur des lots récoltés dans le bassin de Thau (Sète) et sur le littoral des îles Lavezzi (Corse).

L'étude a porté sur 300 spécimens de longueur totale comprise entre 45 et 105 mm.

Les caractères méristiques et métriques pris en considération sont: le nombre de vertèbres (V), d'écailles latérales (E), de branchiospines supérieures (Br.S), inférieures (Br.I), et totales (Br.T); la longueur standard (L), la hauteur du corps (H), la longueur de la tête (T), le diamètre horizontal de l'oeil (O), la distance interorbitaire (I) et la longueur de la base de la première nageoire dorsale (D1).

Il ressort de l'analyse statistique de ces caractères les points suivants:

-Dans le bassin de Thau, on note la présence de deux populations, l'une lagunaire (A) localisée dans la zone sud-ouest et l'autre marine (B) occupant la partie nord-est de ce bassin. Les différences interpopulationnelles portent exclusivement sur les caractères méristiques (Tab. 1).

-Les athérines des îles Lavezzi (C) se distinguent nettement de celles du bassin de Thau tant au niveau de la coloration que des caractères méristiques et métriques (Tab. 1). Ces athérines se singularisent par:

* la présence d'une série longitudinale de tâches noires situées sous la bande argentée,
* un corps robuste et trapu (H/L),
* un oeil remarquablement grand (O/T),
* une distance interorbitaire large (I/T),
* une nageoire dorsale (D 1) relativement courte (D1/O, D1/I),
* un nombre moyen de vertèbres et d'écailles latérales faible,
* des valeurs moyennes du nombre de branchiospines (supérieures, inférieures et totales) intermédiaires à celles des deux populations de Thau.

Le calcul du coefficient de différence (C.D. = x1-x2 /s1+s2 avec x = moyenne des valeurs de la variable, s = écart type) permet d'envisager l'existence de divergences raciales (C.D. > 0,67) et même subspécifiques (C.D.> 1, 28) entre les deux populations d'athérines de Thau et entre ces dernières et celle des îles Lavezzi (Tab. 2).

Tab. 1.- Paramètres statistiques des variables méristiques et métriques (n: effectif; x: moyenne; s: écart type; A: Thau, population lagunaire; B: Thau, population marine; C: Corse, population marine).

	V	E	Br.S	Br.I	Br.T	H/L	O/T	I/T	D1/O	D1/I
n	100	100	100	100	100	100	100	100	100	100
x	44,51	45,33	7,36	18,73	26,09	17,87	31,69	25,74	92,79	114,91
s	0,86	0,90	0,50	0,76	1,03	0,90	1,22	1,61	16,21	18,05
n	100	100	100	100	100	100	100	100	100	100
x	45,78	46,03	9,26	26,29	35,55	18,67	31,50	26,56	81,50	96,73
s	0,92	0,81	0,50	0,98	1,15	0,88	1,23	1,32	9,77	11,88
n	100	100	100	100	100	100	100	100	100	100
x	43,15	42,82	8,14	21,80	29,93	21,73	34,56	31,51	53,90	59,05
s	0,77	0,81	0,49	0,82	1,09	0,86	1,31	1,08	7,53	7,73

Tab. 2.- Coefficients de différences existant entre les variables méristiques et métriques des trois populations A, B et C. (différence raciale: +; différence subspécifique: ++)

V	E	Br.S	Br.I	Br.T	H/L	O/T	I/T	D1/O	D1/I
0,83 +	1,47 ++	0,78 +	1,94 ++	1,81 ++	2,19 ++	1,14 +	2,15 ++	1,64 ++	2,17 ++
1,56 ++	1,98 ++	1,22 +	2,50 ++	2,51 ++	1,76 ++	1,21 +	2,07 ++	1,60 ++	1,92 ++
0,71 +	0,41	1,88 ++	4,34 ++	4,35 ++	0,45	0,08	0,28	0,43	0,61

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The habit diversity of the Kalamas River Delta, N.W. Greece

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Introduction

The Kalamas river delta lies in N.W. Greece (39° 32' N, 20° 05' E) very close to the Greek-Albanian border.

The delta area occupies 7.000 ha and consists of two estuaries which were formed after the initial bed was partially deviated for irrigation purposes. As a result, on the one hand, a large area of the Kalamas delta floodplain was converted into agricultural land, on the other, new coastal habitats developed. As a consequence nowadays there is a great habitat variety of lagoons, salt and brackish water marshes, wet meadows, remnants of riparian forests and reed-thickets as well as island-like hills with phryganic vegetation.

Description of the habitats

Old river estuary: The largest part of the old river estuary has been drained and cultivated. The remaining natural habitats include lagoons and salt marshes. The description of these types of habitats follows.

Lagoons: The lagoons lie in the old estuary region and are characterised by the presence of halophytic vegetation areas either along the banks or on islets in the lagoons. The main species are *Sarcocornia perennis* (Miller) A. J. Scott., and *Arthrocnemum macrostachyum* (Moric.) Moris. On the periphery of the lagoons and at sites of fresh water supply, plant communities of *Juncetum* and *Phragmitetum* are developing while in the lagoon interior the *Ruppietum* community is present.

New river estuary: The new river estuary was created 40 years ago. The pre-existing in the area *Tamarix* forest expanded and took over a large part of the new estuary.

At the newest deposits, plant communities of *Sarcocornia perennis* (Miller) A. J. Scott., *Arthrocnemum macrostachyum* (Moric.) Moris and *Salicornia europaea* L. have settled. These three halophytic communities interchange with each other as well as with the *Tamarix* community, depending on soil salinity and water flooding frequency. Thus, continuous ecotonic communities are created.

In the wider area of the new estuary, and in areas of saline soil which are flooded less frequently a community develops of which the characteristic species is *Halocnemum strobilaceum* (Pallas) Bieb.

At the river's mouth, there are reedbeds of *Phragmites australis* (Cav.) Trin., while in the inside of the river bed, there is a narrow zone of hydrophilous trees, remnants of riparian forests. This zone follows the *Tamarix* forest.

Salt and brackish marshes: The most widely expanded type of salt marshes is the one of *Arthrocnemum macrostachyum* (Moric.) Moris, *Sarcocornia perrenis* (Miller) A. J. Scott., and *Limonium nabronense* Miller This type either forms small islets at a short distance from the coast or is met in coastal areas. In zones close to irrigation channels lying at a slightly ligher level, the communities of *Juncus acutus* L. of *Juncus maritimus* Lam. develop.

Another type of saltmarshes is the one described in the section about the new estuary, which consists of *Halocnemum strobilaceum* (Pallas) Bieb.

On the north of the new river bed, there are brackish marshes resulting from the inflow of fresh water in areas of previous salt marshes. Fresh water inflow was due to the installation of irrigation channels which followed afailing attempt at agricultural exploitation. Vegetation types present in this case are: a) Community of *Scirpus maritimus* L. in areas flooded until the end of spring. b) Reed thickets of *Phragmites australis* (Cav.) Trin. and/or *Typha domigensis* (Pers.) Steudel in areas where fresh water is present almost throughout the year c) *Tamarix* spp forests. *Juncus* strips are also mixed with these zones while in more saline areas there are remnants of *Sarcocornia*. Finally, in the old estuary area, there are remnants of fresh water marshes (*Phragmitetum-Juncetum*).

Riparian forests: Due to cultivation expansion there are only remnants of riparian forests in very narrow zones which widen significantly mainly at a small part of the new river bed.

In this small part, there is variety and alternations of tree thickets of different species like *Platanus orientalis* L., *Alnus glutinosa* (L.) Gaertner, *Ulmus minor* Miller, and *Salix alba* L. Frequently, on the river banks and among tree thickets, there are communities of *Phragmites australis* (Can.) Trin. In the rest of the area, riparian forests-mainly of *Ulmus minor* Miller - have the form of hedges concentrated in zones between the cultivations and the hills.

Island-like hills: The hills are mainly covered with degraded (due to intense grazing) phryganic vegetation of which the principal species is *Phlomis fruticosa* L. In contrast to other areas, vegetation is well developed (high and dense) forming a type of maquis vegetation. The main species are *Quercus coccifera* L., *Olea europaea* L., and *Pistacia lentiscus* L. On certain hills (Mavro Oros, Mastilitsa) *Quercus ithaburensis* Decaisne subsp. *macrolepis* (Kotchy) Hedge & Yalt. is present to a greater or smaller extent. Finally, on certain hot and dry slopes, communities of *Euphorbia dendroides* L. are located.

As is obvious from the above description Kalamas presents a variety of habitats which is also the reason why it is used as a stop-over by many migratory bird species. Therefore the area has already been proposed for inclusion in the list of Ramsar sites in Greece. This communication represents a small part of the initial stage of an ecological study aiming to prove that the Kalamas delta fulfils the criteria for identifying wetlands of International Importance under the Ramsar convention.

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Morphosedimentary evolution pattern during the Late Quaternary of the Oliva-Pego Coastal Marsh System (Valencia, Spain)

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The Oliva-Pego coastal marsh is a small barrier-lagoon system, located in the southeastern end of the Valencian Gulf (Western Mediterranean - Fig. 1), bordered by two Prebetic mountains. The complex corresponds to the "choked lagoon" model from KJERFVE (1986). These landforms are usually found in microtidal coasts and they are characterized by their restricted connections to the open sea. However, the wetland deeps a quite steady paludal morphology with a widespread development of marshes but has not been fully filled despite the large amount of sediments that have been accumulated in the bassin, as this wetland is well supplied by groundwaters and it is placed on an area of enhanced land subsidence. This last factor is essential to the functionality of the system and thus this coastal landform can persist a long time (NICHOLS, 1989).

Geomorphological study and tectonic evolution of the area, as well as sedimentological, micropaleontological and chronological analysis of the materials from subaereal profiles and core-holes are carried out. We have added the information from electric soundings and ecoseismic profiles of the marine shelf.

We can observe from all these data, that the present morphosedimentary barrier-lagoon pattern is not similar to the ones developed during previous moments of the Late-Quaternary. In the Pleistocene record (mainly related to the isotopic states 4, 3 and 2 deposition) important thickness of well oxygenated lagoonal sediments from fresh and/or brackish waters are detected. These features suggest that the ancient systems were larger and "leakier" with better connections between the open sea and the lagoon (VIÑALS, 1991). So, we can deduce that a well hydric exchange and entrances of marine waters with euryhaline fauna took place. Sedimentation in these environments was controlled mainly by chemical processes of precipitation, principally carbonates (some times they meant a 98% of the grains). The marine regressions caused the emergence and consequently the drying of the bottom of theses lagoons, together with the climatic aridity were responsible for the eolic erosion of the sediments surface.

The morphostratigraphic pattern of evolution derived from the sequential analysis and the tridimensional display of the units allows us to point out the following:

- The sedimentation of the last 125.000 years testify the development of barrier-lagoon complexes, where the lagoonal, marin and barrier facies alternances are observed (Fig.2).

- The sedimentary bodies geometry and the deposits sequences are the result of the relation between the high land subsidence late, the relative sea level oscillations and the kind and quantity of sediments that reach the coast.

- In a simplier morphostratigraphic approach and in the limited range of sedimentary settings in which insert the coastal environments migration, the lagoonal units represent episodes of marine regression or coastal progradation; while the beach-barrier and marine units are associated to sea positive pulses or transgressions, that often cause a coastal retreat.

The prequaternary palaeotopography bassin explains the perseverance in the formation of these coastal systems and the succesion of different morphosedimentary patterns from the Pleistocene to present time. The proximity of the mountains end to the coastline and the land subsidence have influenced the changes of the barrier-lagoon bodies morphology, causing the onlapping and retrogradation of the different highest sea levels. So, each new littoral body is more inland located than the older ones, chocking more and more the lagoons and changing them into small cellules or "pocket lagoons", that are closed by a very hermethic barrier tha-encourages the accumulation of the organic muds in the inner part of the system. This model reached its maximun development during the Flandrian transgression (5.7-10±100 and 5.330±90 BP).

Fig. 1: Surveyed area

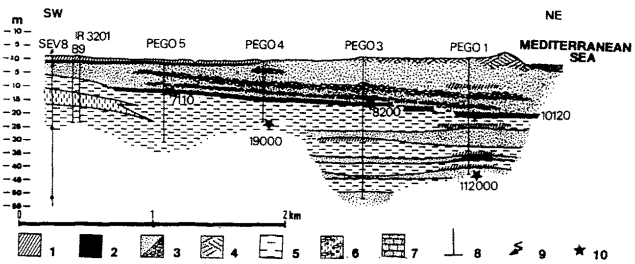

Fig.2: Barrier cross section of the Oliva-Pego Marsh. 1. Organic muds; 2. Presh/brackish marsh; 3. Beach-barrier/Marine environment; 4. Eolic deposits and dunes; 5. Lagoon; 6. Alluvial fan deposits: 7. Calcoarenitc formations; 8. Core-hole; 9. Electric sounding; 10. Absolute dating.

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Methodological aspects and first results of the study of decomposition of *Phragmites australis* Trin. in the coastal wetland "Albufera de Mallorca" (Spain)

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Aspects of decomposition of *Phragmites* have been experimentally studied in the Albufera de Mallorca. The objectives were twofold: to determine the effect of different shapes and mesh size of containers on decomposition rates of leaves and culms. Secondly, to carry out parallel studies on fungal colonization of the decomposing fractions.

The Albufera de Mallorca has a surface area of 24 Km2. The temperature range for water in lagoons is 10 to 29°C. The salinity in these lagoons in the different areas is very variable and depends mainly on drainage rates in the rainy seasons (MARTINEZ, 1988).

In December 1990 standing dead leaves and culms were collected and stored air dry. In March 1991 they were cut into portions and triplicate random samples were put in 2 mm mesh bags (6.6 g) and 5 mm mesh cages (7-10 g dry wt). Leaves were recovered after 32 and 92 days, and culms after 121 and 211 days.

In the laboratory samples were grossly blended and sampled for mycological studies, and the dry weight of the remaining matter determined.

Results

A. Weight loss.

The loss of leaf biomass in bags after 32 days was half that of the cages. After 92 days incubation differences are not so significant (63% and 71.2% respectively) (Table 1).

	Cummulative days	mesh-size (mm)	loss weight	decomposition rate (in %).
leaf	32	2	0.73±0.09	0.343
	32	5	1.39±0.29	0.659
	92	2	3.99±0.10	0.548
	92	5	4.72±0.18	0.835
culms	32	2	2.66±0.32	0.188
	32	5	2.58±0.16	0.209
	92	2	3.51±0.16	0.087
	92	5	3.85±0.10	0.087

Table 1- Decomposition of *Phragmites* leaves and culms

Differences in loss of culm biomass were not so great between bags and cages. The values obtained at 121 and 211 days incubation are very similar.

POLUNIN (1982) stated that 80% of the weight loss of *Phragmites* leaf biomass in the first 20 days is due to leaching. This allows us to presume that the 2 mm mesh may interfere more significantly than that of 5 mm in this process.

Table 2 shows the instantaneous decomposition rate (K) calculated according to the exponential model of OLSON (1963). The decomposition values obtained for either leaves or culms in both types of container are very similar. Differences are not important in the final results. But there is a great difference between K values for leaves and culms. These differences are clearly shown for half decomposition times (T 1/2). In contrast to our results, MASON & BRYANT (1975) and ANDERSON (1978), using 4 and 0.25 mm mesh bags, obtain values for half decomposition times of 7-11 months. These marked discrepancies are probably mainly due to the difference in temperatures, as their studies were carried out in England (52° lat.).

	Cummulative days	mesh-size (mm)	loss weight	Kx100	T1/2
leaf	92	2	60.31	1.3	53.32
	92	5	71.22	1.7	40.77
culms	211	2	30.71	0.119	581.0
	211	5	33.04	0.121	574.8

Table 2.- Decomposition of *Phragmites* leaves and culms. K= coefficient of regression. T 1/2 = time of semi-decomposition

B. Preliminary mycological observations.

Plant tissue was surface sterilized with bleach and subdivided into two portions. One was moist-incubated at 15°C in sterile Petri dishes under NUV to induce fruiting, and the other was cut into small portions (approx. 2mm square) using sterile technique for pure culture. These were immersed in antibacterial isolation media, the resulting colonies being transferred individually onto 2% malt extract agar or *Phragmites* leaf agar. After incubation at room temperature, or at 15°C with or without NUV, sporulating or fruiting colonies were examined microscopically, and the remaining were submerged for two or more days in autoclaved Albufera or distilled water in Petri dishes under the same conditions, to induce sporulation of aquatic states.

Species determinations are underway, but it may be concluded at this stage that practically the entire plant biomass of both leaves and culms appeared to be colonized by microfungi, and that these belonged to very few species, (a probable case of saprophytic spacialization) mainly to presumably terrestrial lepto-sphaeriaceous ascomycetes and pycnidial coelomycetes (often fruiting at the bottom of the plates), with only some hyphomycetes. Submerged incubation of cultures proved unsuccessful, but that of *Phragmites* culm fragments yielded numerous conidia of a dematiaceous scolecosporous aquatic hyphomycete (in the genus *Anguillospora)* which is apparently new to science. Many isolates remained sterile, probably due to inadequate sporulation conditions, and this problem is now being looked into.

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E

La lutte contre l'eutrophisation des Lagunes Littorales Méditerranéennes

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Les crises dystrophiques (malaïgues) qui touchent les lagunes méditerranéennes augmentent en fréquence et en gravité. Les interventions qui visent à enrayer ce phénomène peuvent être raisonnées à partir:

(1) d'une analyse des expériences de réhabilitation (Tunisie, Italie), à la base desquelles il y a une réduction maximale des apports des bassins versants. Des opérations complémentaires sont nécessaires (dragage de sédiments ou collecte d'ulves, introduction d'eaux marines);

(2) de l'évaluation des stocks et des apports d'azote et de phosphore, éléments clés de l'eutrophisation, aux différents niveaux du système lagune-bassin versant et sur lesquels une intervention est possible: apports des bassins versants, stocks et relargage des sédiments, stocks dans les ulves. Une étude (LIEUTAUD *et al.*, 1991), portant sur huit étangs du littoral méditerranéen français (de l'étang de l'Or à l'étang d'Ingril, figure 1), montre que:

- les **apports** les plus importants sont actuellement ceux des bassins versants, précédant largement ceux des flux en provenance des sédiments.

Les apports des bassins versants ont une origine urbaine, dominante dans quatre cas, ce qui permet d'envisager une très forte réduction. La situation est plus délicate ailleurs, notamment lorsque les apports d'origine agricole sont importants. Pour l'azote, deux autres sources d'apports peuvent être non négligeables: apports directs par pluie et apports par les nappes.

Les apports par relargage du sédiment sont faibles devant ceux des bassins versants et les interventions à ce niveau doivent donc intervenir après celles sur les bassins versants. Ces apports sont néanmoins non négligeables, puisqu'on estime par exemple qu'ils peuvent engendrer à eux seuls de fortes proliférations d'ulves. Les interventions sur les flux des sédiments posent des problèmes techniques particuliers dans le cas des lagunes et devraient faire l'objet d'expérimentations pilotes. En particulier, il est inutile de tenter des apports de fer (complexation du phosphore) comme cela peut être pratiqué ailleurs, en raison de l'anoxie estivale (rupture de la liaison entre fer et phophates).

- les **stocks** les plus importants se situent au niveau des sédiments. Leur distribution spatiale reflète les principales zones d'apports du bassin versant. Les teneurs en phosphore diminuent avec la profondeur, ce qui n'est pas le cas de celles en azote. Le dragage ne permettra donc pas toujours de réduire ces stocks (en particulier pour l'azote).

Les ulves représentent, en période de forte prolifération, une nuisance mais aussi un stock d'azote et de phosphore qui est du même ordre de grandeur que celui du flux annuel du sédiment. La collecte des ulves ne pose pas de problème technique, mais le nombre d'engins, le rythme et les périodes de ramassage doivent être adaptés a l'objectif recherché (extraction d'azote et de phosphore ou élimination de la biomasse). La biomasse collectée n'a pas, à ce jour, trouvé de valorisation à une échelle économique réelle.

(3) de l'efficacité et des coûts d'intervention. L'extraction de phosphore est plus importante et moins coûteuse par kg d'ulve que par kg de sédiment, mais globalement limitée à la croissance des ulves. Pour l'azote, la collecte d'ulves n'est intéressante qu'à certaines périodes.

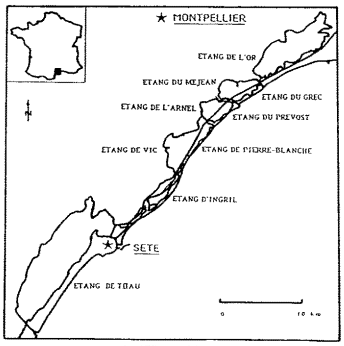
(4) du rôle de l'azote et du phosphore comme facteurs limitants le développement des ulves. Ceci a été abordé, plus ou moins directement, par divers auteurs (MENESGUEN, 1989; SFRISO *et al.*, 1987; VIAROLI *et al.*, 1990). Dans nos observations, comme dans celles d'autres auteurs en Méditerranée, il apparaît que l'azote assimilable est absent de l'eau durant une partie de l'année, alors que le phosphore assimilable ne l'est jamais. Les seuils de réserves internes en-dessous desquels la croissance s'arrête ont été évalués au laboratoire (0,7 % et 0,3 % de la M.S. respectivement pour l'azote et le phosphore). Sur le terrain, les réserves en azote sont très variables et peuvent être tres inférieures au seuil limite déterminé au laboratoire (0,1 %); celles en phosphore fluctuent moins et descendent peu en dessous du seuil limite (0,25-0,27 %). Ceci conduit à penser que l'azote serait bien le facteur limitant la croissance des ulves en lagune méditerranéenne.

En pratique, si la réduction de l'azote semble souhaitable, elle apparaît plus difficile que celle du phosphore, pour plusieurs raisons:

- les apports d'azote, en partie sous forme diffuse (agriculture), sont difficiles à maîtriser, et les teneurs dans les nappes souterraines sont parfois non négligeables,
- les apports en azote par les pluies tombant directement sur les plans d'eau ne sont pas maîtrisables,
- il y a de fortes teneurs en azote "biodisponible" dans les sédiments, y compris en profondeur; les teneurs en phosphore "biodisponible" diminuent nettement avec la profondeur,
- le phosphore des sédiments, alimentant les flux vers l'eau (orthophosphates), peut éventuellement etre inactivé par complexation chimique, alors que l'azote ne le peut pas.

Pour préciser l'effet de l'abattement des apports du bassin versant en azote et/ou en phosphore, une modélisation, sur le modèle de celle des "marées vertes" de Bretagne, sera ultérieurement réalisée.

Figure 1. Situation de la zone d'étude



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E

La production d'anguilles des Lagunes de Méditerranée française
Comparaison des sources statistiques-Rendements et cycles de production

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Les lagunes du littoral de la Méditerranée française font l'objet d'une pêche de type artisanal dont l'espèce cible est l'anguille. La production globale est mal connue, la seule information dont on dispose jusqu'a présent repose sur les statistiques officielles dont on n'a jamais vérifié la pertinence. Le présent travail les compare à d'autres informations confidentielles d'ordre professionnel. On utilise ensuite une des sources d'information pour décrire les rendements et les cycles d'exploitation.

Les sources d'information

Les statistiques administratives (Affaires maritimes et Douanes) se situent à deux niveaux différents de la commercialisation du produit.

Les Affaires Maritimes estiment la production par lagune, selon des procédures locales diverses. Les Douanes enregistrent les tonnages exportés, en trois catégories, selon la présentation du produit, mais sans distinguer les civelles et les anguilles; la pêche de la civelle étant interdite en Méditerranée, la totalité du tonnage correspond à des anguilles. Afin d'identifier la production de Méditerranée, les statistiques (confidentielles) par département d'origine sont utilisées.

Une autre source statistique peut être utilisée. Les entreprises de mareyage effectuent **le "ramassage" et la commercialisation** de la pêche, essentiellement en vif, et contrôlent l'essentiel des achats et des ventes. Il est exceptionnel que les pêches soient écoulées directement par les pêcheurs.

La différence entre les statistiques de production (Affaires Maritimes et mareyage) et d'exportation pourrait correspondre à l'écoulement sur le marché intérieur; les investigations réalisées n'ont pu mettre en évidence que de très faibles tonnages.

Production de la façade méditerranéenne française

L'estimation des productions annuelles à l'échelle de la Méditerranée est en général plus élevée avec les statistiques de mareyage. Selon cette source, la production annuelle (années 1980-1985) se situe entre environ 1500 et 2300 tonnes par an. Les écarts avec les statistiques douanières sont faibles; ces dernières tendent généralement à sous-estimer légèrement (6 à 8%); il y a concordance entre les deux sources pour une année (2% d'écart). Les tonnages estimés par les Affaires Maritimes sont toujours inférieurs à ceux des statistiques de mareyage, avec une différence non constante (7 à 38%).

Production par secteurs

La façade méditerranéenne a été découpée en secteurs géographiques communs aux différentes sources statistiques (figure 1). Dans les secteurs "Palavas" et "Aude", les estimations selon les statistiques des Affaires Maritimes s'accordent bien à celle des entreprises de mareyage; ailleurs, elles sont inférieures.

Les statistiques de mareyage ont donc été retenues, et ventilées par secteur, montrant l'importance du secteur "Berre", qui produit près de la moitié des tonnages méditerranéens français (figure 1). L'expression par unité de surface en eau (exploitable)[1] conduit à considérer que c'est dans le secteur "Corse" (étang de Biguglia: 60 kg/ha/an), puis "Berre" (43 kg/ha/an) que les rendements sont les plus élevés. Le secteur "Aude" est en position intermédiaire avec près de 38 kg/ha/an; viennent ensuite les secteurs "Palavas" et "Thau" (avec respectivement 28 et 21 kg/ha/an). Ces résultats doivent être nuancés pour les secteurs où la surface "exploitable" peut différer sensiblement de la surface réellement "exploitée": c'est le cas des secteurs comprenant une mosaïque de petits plans d'eau dont l'usage réel est mal connu et variable (secteurs "Palavas" et "Camargue"). Par ailleurs, la valeur moyenne n'a pas de sens dans les secteurs où on observe une forte hétérogénéité des plans d'eau ayant des rendements différents (secteur "Aude", "Palavas") ou incluant la production d'un estuaire (secteur "Camargue").

Cycles d'exploitation

Dans certains secteurs ("Aude", "Camargue" et "Corse"), le cycle de production est resté de type traditionnel, avec des captures plus importantes en automne (fig. 2A). Ailleurs, les conditions environnementales (comme l'anoxie estivale des eaux qui provoque la fuite et la capture massive de poissons) et commerciales (proximité des entreprises de mareyage), conduisent à des productions élevées précoces, printano-estivales (fig. 2B).

Figure 1. Délimitation des secteurs géographiques du littoral méditerranéen français, avec indication du pourcentage de production de chacun.

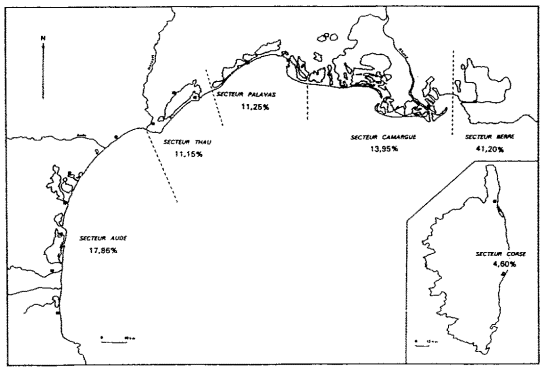
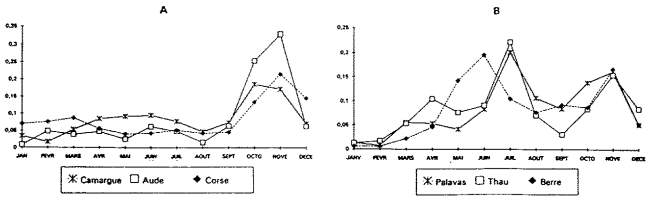


Figure 2. Cycles de production par secteurs (fréquences relatives mensuelles)



[1] Sont exclus tous les plans d'eau isolés et affectés exclusivement à un autre usage que la pêche

Gonadotropin (GtH) and steroid hormones in the plasma and pituitary of *Mugil capito* at various states of maturation

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Fish (*Mugil capito*) was collected from a fresh water fish farms, raised in a pond up to the age of 2 years weighing between 118 and 408 g, were brought to the laboratory and stocked in a fiber glass tanks at room temperature. The experiments were conducted through out a year.

Blood samples were taken from all fish from a caudal vein with a heparinized syring. the blood was centrifuged for 10 minutes at 6000 Rpm, at 4°C. The plasma was collected and kept frozen until use for GtH, testoterone and progesterone - RIA determination. Fish weighed and killed by decapitation. Pituitaries homogenized in 0.5 ml of Tris-Hcl buffer pH. 8.6 and stored frozen in preparation for radioim munoassay. The gonads were removed and weighed. The classification of gonads was used to assess the degree of development (ZAKI and EL-GHARABAWY, 1991). In addition, the various developmental stages were related to gonadosomatic index (GSI; gonad weight as expressed as a percentage of gutted bofy weight).

Plasma and pituitaries were extracted and assayed for gonadotropin by a radioim munoassay (RIA) procedure using (ICN Biomedicais. Inc. Diagnostic Division, Cat. no. 07 - 156102).

Plasma and pituitaries were extracted and assayed for testosterone and progesterone by a radioim munoassay (RIA) procedure using pantex immunocoat -^{125}I- Cat. n°335 for testosterone and Cat. n°337 for progesterone.

The aim of the present study is to determine gonadotropin and testosterone content in plasma and pituitary. Besides the determination of progesterone in plasma for both sexes of *Mugil capito* allover the year. To give us the changes which occur during the sexual cycle.

Plasma and pituitary gonatropin levels, testosterone and progesterone were measured using radioim munoassay during the maturation stages. The seasonal variation in plasma gonadotropin concentration for *Mugil capito* was examined in relation to sexual maturation. Plasma GtH values reached minimum in immature male and female *Mugil capito*. Sexual maturity of both sexes was related to significant increase in plasma gonadotropin with the highest values observed for males near the times of spermiation.

Pituitary GtH content was lowest in immature, mature, nearly ripe and spent stages of male and female *Mugil capito* with an increase in ripe female *Mugil capito* collected in December. During the spawning season (October-February) mature female *Mugil capito* hand plasma progesterone content higher than that found in sexually mature male *Mugil capito*. In female *Mugil capito*, a decrease in plasma testosterone levels occured around the time of ovulation which was accompanied by a sharp rise in plasma GtH levels, Seasonal increase in plasma testosterone levels occured around the time of ovulation which was accompanied by a sharp rise in plasma testosterone appeared to be involved in the ripe male *Mugil capito*. The increase in plasma testosterone levels in ripe male and in pituitary testosterone in female *Mugil capito* is highly correlated with the increase in gonadosomatic index.

Spermatogenesis and induced spawning of male *Mugil capito* reared in fresh water fish farm

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The testis of *Mugil capito* is of the percoid type. The testicular tissue of *Mugil capito* is calssified into six stages: In mature, mature prespawning, spawning, spent and resting stage. The testis of *Mugil capito* undergoes regular cyclic changes.

Males of *Mugil capito* were collected monthly from aquatic region; Boughaz lake Edku representing the testis under natural condition of spawning; from Nozha hydrodrome (fresh water fish farm) and from Damistta fish farm (brackish water). total length, total weight, stage of maturity and the date of capture were recorded. Their abdominal cavity was opened and the testes removed, fixed in Bouin's solution. After that the gonads were dehydrated, cleared and embedded in paraffin. Six mm thick sections were stained with eosin and haematoxyline and iron haematoxyline. For the induced spawning, *Mugil capito* males, up to the age of 2 years (weight: 118 to 408 g.), were brought from a pond to the laboratory and stocked in a fiber glass tanks at room temperature. Males kept at 18° C and under photoperiod (12 L: 12 D) recieved and injection of GTH (1500 IU/Kgm.) as first dose and (2000 IU/Kgm.) as a commulative dose. After hormonal stimulation, the milt was collected after the first and second injection. Milt volume, sperm count were measured after injections using the technique of Mosselios (1951).

The aim of the present work is to describe spermatogenesis to give us information about seasonal changes in the reproductive cycle of *Mugil capito* and also to determine the quantity and quality of spermatozoa produced by the injection with chorionic gonadotropin hormone, which is essential for artificial fertilization of this fish species.

The spermatogenic activity starts in late August and gradually increases till October, reaching maximum in late October and November. The process of spermatogenesis decreases and almost ceases by March, the testis passes through a resting period from April to late August. The activities of spermatogenesis were affected by slight increases in temperature.

In *Mugil capito*, asynchronous entry of the primary spermatogonia into the reproduction period, results in formation of the additional portion of spermatozoa. On the other hand, prolonged spawning in *Mugil capito* is enhanced.

After hormonal stimulation, the quantity and quality of spermatozoa which produced from *Mugil capito* are measured. It shows that the volume collected is maximum after 48 hr. (commulative dose 2000 IU). After three days the mean volume of milt is decreased and none could be collected after four days. The number of sperm collected after injection with commulative dose (2000 IU GTH) is more than those collected after injection with one dose of cGTH (1500 IU).

E

Morphology and Sedimentary environments of the menorca Canyon head

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Los fondos submarinos de las Islas Baleares constituyen un magnifico ejemplo de plataforma carbonatada de mares templados y latitudes medias. La morfologia submarina esta caracterizada por la presencia de varias terrazas,y extensos campos de dunas submarinas.
Se han diferenciado seis comunidades bentonicas responsables de la alta productividad de carbonatos (70g. $CaCO_3$,/m-2/y-1) distinguiéndose cinco grandes tipos de sedimentos, que corresponden a otros tantos dominios sedimentarios.

Keywords : Menorca canyon, sedimentary environments, morphology

The maps, block diagrams and seismic lines illustrating this poster, integrate multidisciplinary coastal and submarine data which should serve as a documental basis to better know, use and protect these environmentally fragile areas.
The balearic Islands offer to the scientific community an excellent example for non-tropical carbonate shelves. Seafloor morphology, benthic communities and sediment types are in fact, strongly interdependent. The south Menorca Shelf and upper slope show these interdependences particulary well.
Seafloor morphology is characterized by several submarine terraces. Extensive sand wave fields develop from the lower limit of seagrass communities to 50 m. deep. Two major sand transport directions appear : A) 110° -140° and B) 190° - 205° ; the first being related to the dominant longshore currents, and the second probably due to weaker helical currents issued from the main flow.
A great variety of mass movement processes, ranging from creep-faults to slide lobes and glided blocks, develop around and on the Menorca canyon headwalls ; each mass movements appears to be concentrated at specific areas.
From coastline to upper continental slope, the benthic communities responsible for carbonate production are :
1) Photophilic algae (0-5 m.)
2) Posidonia Oceanica seagrass meadows (1-30 m.)
3) Sandy communities with the algae Vidalia volubilis (30-45m.)
4) Loose branching calcareous algae "maërl" (35-70 m.)
5) Shelfbreak bryozoans (90-120 m.)
6) Communities of suspension feeders of the uppermost slope.

Overall mean carbonate production in the photic zone (to 150 m.) is around 70 g. $CaCO_3$,/m-2/y-1. Five main sediment types appear in the area of study :
A) Algal sands
B) Bioclastic sands
C) Bryozoans sands
D) Terrigenous sands
E) Pelecypod sands

As a result, five sedimentary domains define the South Menorca continental shelf :
I) Littoral sandy prism (0-5 m.)
II) Seaflor protected by seagrasses (5-38 m.)
III) Sand wave field indicative of tractive transport (38-50m.)
IV) Bypass zone with rough microtopography and submarine terrace development
V) Canyon head cirque.
Inner, medium and outer continental shelf are thus define in terms of sediment types, seafloor morphology including bedforns and sediment dynamics.

Comparing examples of modern Turbidite systems associated with restricted basins in the Western Mediterranean Sea

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The Ebro and Andarax deep-sea depositional systems offer a good opportunity to analyze the Plio-Quaternary growth patterns of turbidite systems developed in morphologically restricted basins. The Ebro turbidite systems are located between the base-of-slope of the Ebro margin and the basin floor of the Valencia Trough, which is confined between the Iberian Peninsula and the Balearic Platform (Fig. 1A). This passive margin of the northwestern Mediterranean was largely structured during the Early Miocene by subsiding grabens parallel to the Iberian margin, which developed a narrow slope, while recent tectonic activity is minor (NELSON and MALDONADO, 1988). Important sediment supply to this system is derived from the Ebro River. The Andarax turbidite system develops between the base-of-slope of the Almeria margin and the basin floor of the Alboran Trough, which is bounded by the Alboran Ridge in the eastern Alboran Sea (Fig. 1B). This area, one of the most tectonically active regions of the Mediterranean Sea, is characterized by compressional tectonic and strike slip-faults, which affect the most recent deposits (WOODSIDE and MALDONADO, 1992). Sediment supply is derived from the Andarax River during major seasonal floods.
Both systems have a similar physiographic setting defined by narrow, steep slopes, the base-of-slope region occupied by turbidite systems, and the gentle sloping basin floor of the restricted trough. These systems reveal, however, significant differences for the overall growth patterns. While the Ebro systems depict many variations in comparison to deep-sea fans, there are similarities in the Andarax system with classical examples (ALONSO *et al.*, 1990; ALONSO and MALDONADO, 1992). Differences in growth patterns of Ebro turbidite systems include: (1) the presence of multiple slope canyons, (2) the development of successive Ebro channel-levee complexes from newly created slope canyons, (3) the absence of depositional lobes, and (4) the by-passing of sediments from the Ebro turbidite systems to the distal Valencia Fan deposits (ALONSO and MALDONADO, 1990). The growth patterns of the Andarax turbidite system are, in contrast, more similar to classical submarine fans. Similarities include: (1) a single canyon to levee upper fan, and (2) the development of channel-levee complexes, which evolve distally to depositional lobes located in the basin floor of the Alboran Trough (ALONSO and MALDONADO, 1992).
The incomplete development and truncation of the Ebro turbidite systems have been previously attributed to the tectonic control of the Valencia Trough margin, which may inhibited the growth of depositional lobes (SHANMUGHAM and MOIOLA, 1988). It is observed, however, that in the more tectonically active Alboran Trough complete, deep-sea fans with lobes are developed. We suggest that the main factors controlling the development of depositional lobes are the combination of depositional processes and physiography, which in turn are related and modified by the structural setting in both depositional systems. In fact, the Valencia Trough is incised by a deep-sea channel, the Valencia Valley which as a major sediment convey to the distal depositional sectors, as revealed by the mineralogical composition of turbidite sands of the Valencia Fan (PALANQUES and MALDONADO, 1985). In contrast the flat floor of the Alboran Trough is not incised by any deep-sea valley (Fig. 1B). This flat depression traps sediment flows and it allows the development of depositional lobes, in spite of the very active tectonic disruption of the most recent deposits (WOODSIDE and MALDONADO, 1992). The structural evolution is an important factor controlling the overall physiographic setting and depocenter distribution of these turbidite systems, but other factors such as sediment supply and processes are also significant for the development of specific depositional environment.

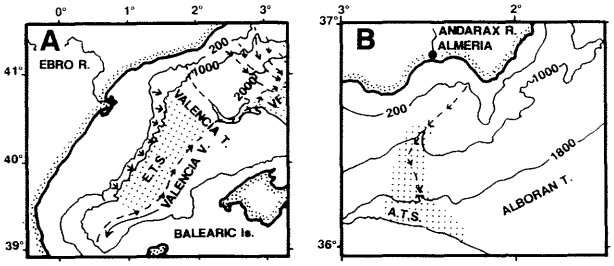

Figure 1. Physiographic setting of (A) the Ebro turbidite systems (E.T.S.) and (B) the Alboran turbidite system (A.T.S.) in the western Mediterranean Sea. Dashed arrows indicate main canyon axes. T, trough; V, valley; VF, Valencia Fan; R, rivers; Is., islands.

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G

Tectonic evolution of basins in Northeastern Mediterranean Sea

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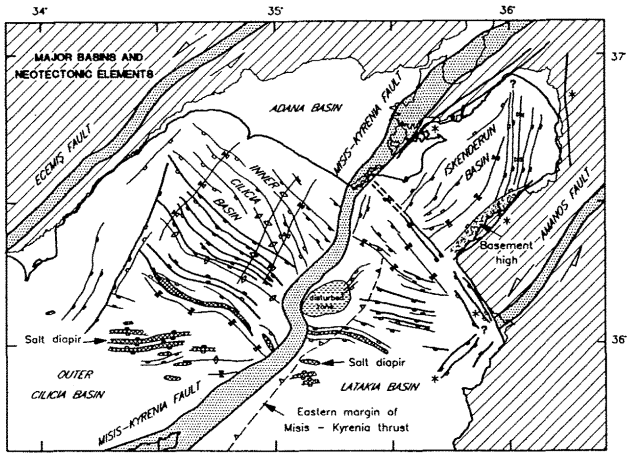
The present-day tectonic framework of the Eastern Mediterranean is controlled by the last phase of collision between the African and Eurasian plates, in particular the displacements of the smaller Arabian, Syrian, Anatolian and Aegean plates. The Aegean/Anatolian plate is pushed westwards along strike-slip faults, due to collision between the Arabian/Syrian and Eurasian plates along the Bitlis-Zagros Suture (SENGÖR and YILMAZ, 1981). The North Anatolian Transform Fault moves dextrally, while the East Anatolian Transform Fault shows a complementary sinistral motion. There are a number of subsidiary faults to the East Anatolian Transform Fault, such as the Ecemis and Sungurlu Faults. To the west, the Anatolian plate merges with the Aegean plate with an intervening diffuse plate boundary, characterized by E-W trending grabens. At its northeastern edge, the African plate is presently moving NNE relative to the Eurasian plate. The boundary between the African and the Anatolian plates is delineated by the Hellenic Arc and Pliny-Strabo Trench in the west and the Cyprus Arc and a diffuse fault system probably associated with the Amanos Fault in the east. The two arcs are near perpendicular to the relative motion of the African and Anatolian plates, delineating the subduction zones, whereas the Pliny-Strabo Trench and East Anatolian fault zones (including the Amanos and Ecemis Faults) are subparallel to the slip vector, with predominantly transform motion. The boundary between the African and Arabian plates is characterised by sinistral strike slip motion along the Dead Sea Transform Fault.

The study area is located at the edge of the Anatolian platform, immediately southwest of the Africa/Arabia/Anatolia triple function (DEWEY *et al.*, 1986), and includes four genetically related basins: Adana, Cilicia, Iskenderun and Latakia Basins. These four bssins collectively form a moderately large semi-enclosed depocentre in the northeastern Mediterranean Sea and provide an excellent opportunity to study the tectonic and sedimentary evolution of depocentres near the edge of active orogenic regions with complicated microplate configurations. They offer a modern analogue for ancient sedimentary troughs, which evolved in continental collisional settings.

Detailed interpretation of ~5000 km of seismic reflection profiles from the northeastern Mediterranean Sea showed the followings (AKSU *et al.*, submitted): (1) During the Pliocene-Quaternary, extension took place in the NE corner of the Mediterranean Sea by listric faulting on a decollement surface at the base of the Messinian evaporites. The extensional basin in bounded by two sinistral strike-slip splays : Ecemis and Amanos Fault, and subparallel listric fault that sole much deeper than the Messinian evaporites. The former Misis-Kyrenia thrust belt may also have acted as a strike-slip fault, although its surface expression is as a horst block. The decoupling at the base of the evaporites has resulted in listric fault fans and roll-over anticlines almost orthogonal to the bounding faults. (2) The evolution of Pliocene-Pleistocene depocentres was largely controlled by the Misis-Kyrenia horst and the listric fans and associated roll-over anticlines, which shifted position through time, creating a shifting pattern of depocentres. (3) The extensional collapse of the Adana-Cilicia-Iskenderun-Latakia basin complex resulted in overall retreat of the coastline in Cilicia and Latakia basins during the mid- to late Quaternary. The continental shelf subsided sufficiently rapidly to trap most sediment on the shelf. Delta plain gradients were low, so that coarse sediment was trapped far inland. In the mid-late Quaternary, deep-water turbidites occurred only at extreme lowstands of sea level. This late-orogenic extensional basin resembles neither classical "flysch" or "molasse" type basins : the fill is principally deltaic shales. (4) Four types of depocentre are distinguished : (A) depocentres landward of the maximum paleoshorelines in which accommodation space between two transgressive surfaces that was created almost exclusively by tectonic subsidence; (B) thick sediment accumulations near paleoshorelines, particularly where a depositional sequence prograded further seaward than the underlying depositional sequence; (C) isolated depocentres in deep water controlled by halokinesis and (D) small deep water turbidite basins fed by fault-controlled channels.



Tectonic map of the area, showing the Ecemis, Amanos and Misis-Kyrenia Fault zones, major faults, salt diapirs/ridges and anticline and basin axes.

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Marine Geological Geographic Information System (G.I.S.) of Aegean Sea of Greece

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The digital organization of Marine Geological Data of Aegean Sea of Greece and the development of a Computer based Marine Information System from the available Marine Data Sets, helps for better understanding of the natural environments at all scales from local to global.

The reason for the creation of the Marine Information System of the Aegean Sea was:

- The urgent need for the better distribution of available data sets, coupled with improved data management facilities to enable more efficient access to the increasing volume of marine data.
- A requirement for data integration and compatibility, in an increasingly multidisciplinary environment.
- The correlation evaluation and interpretation of the existing data.
- The extraction of data in various combinations.

To create a Data Bank with high credibility, a "systematic validation" has been undertaken for the data collection according to generally accepted specifications.

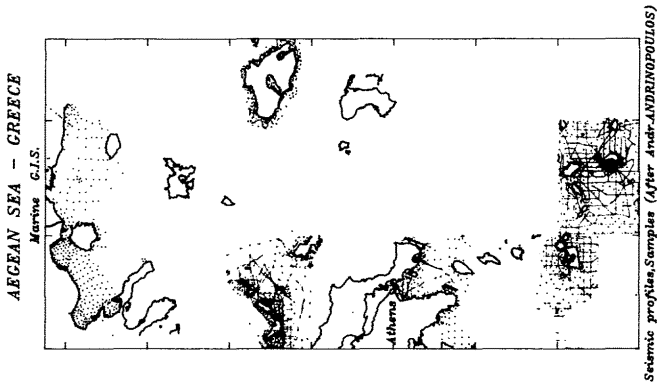
The collected data consist of the first Data Bank levels, which are created during the field-trip work on the ship. The second Data Bank levels are added to the first one and contains various data classified into groups.

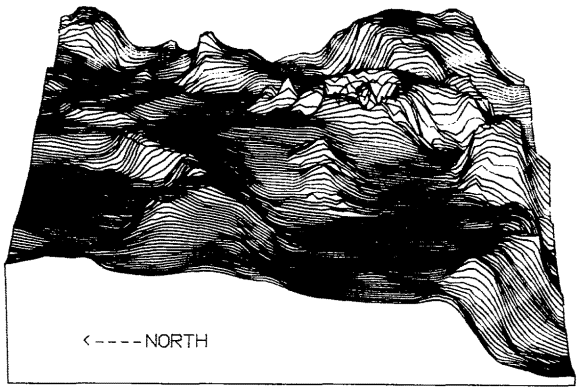
The addition of Data Bank levels vertically and horizontally is one of the advantages. Vertical addition means entering new data which belong to the same group of the existing data or consists of new groups of data. At all the vertical levels there is a compatibility. Horizontal addition means the joining of the adjacent areas in which there are similar data available.

Maps can be produced showing all the available data and any correlations between them.

Other big advantages of the Marine Geological G.I.S. of the Aegean Sea are the possibility of evaluation and presentation of the different data for various windows at any scale, the creation of detailed bathymetric maps, accurate geostatistical evaluations and the construction of 3-D models.

It is also possibile to development an expert system which will allow access to fully developed numerical models and the refinement of existing 3-D models to help investigation.





Bathymetry of Santorini sheet, developed from the Marine Geology G.I.S. for the Aegean Sea of Greece (after A. Andrinopoulos, 1992)

The distribution of sediments in South Aegean Sea : A marine G.I.S. application

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The data evaluation and the distribution of Sediments in the Southern Aegean Sea presented in this report, is part of the Marine Geological Geographic Information System (G.I.S.) of the Aegean Sea. The investigated area includes part of the Hellenic Volcanic Arc (Santorini, Milos islands) and the surroundings (Amorgos, Folegandros islands). The research was sponsored by the EEC, MAST I, project.

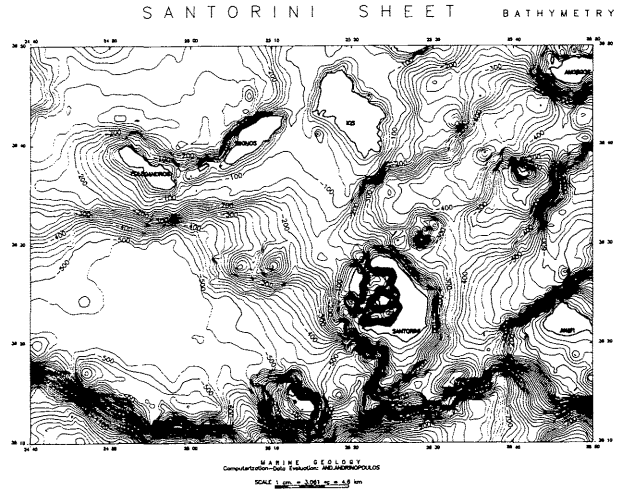
Geologically, the area comprises 3 units :

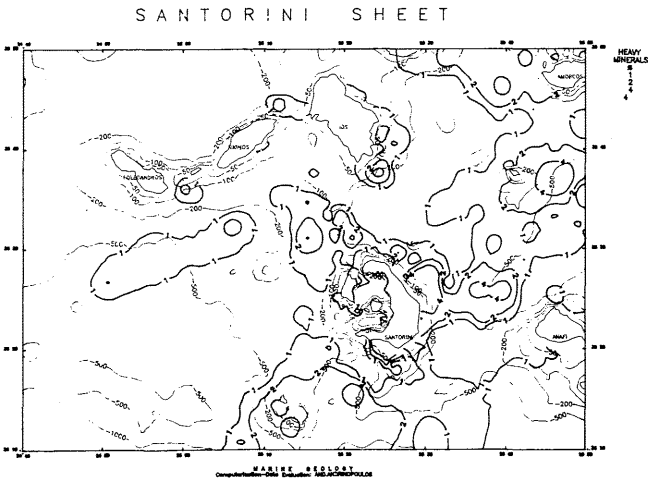
The first unit consists, mainly, of igneous rocks (Santorini, Milos), the second of metamorphic (Sikinos, Folegandros) and the third of sedimentary rocks (Amorgos).

As far as the sea floor is concerned, there are three sea-floor levels : the first one is appr. at 200m (Folegandros, Sikinos, Ios) the second one is at appr. 500m (basin in the west of Santorini) and the third one is deeper than 1000m (in the Southern area). These three levels are confined by faults of two main directions NW-SE and NE-SW.

The granulometry and microscopic analysis of the seabottom sediments have shown the following :

- Standard Deviation : The values range mainly from 0.35φ to 2φ. The contour of 2φ includes the most of the islands and the values decrease in a lot of areas, close to the islands.
- Heavy minerals : The distibution of the Heavy mineral values is irregular. In the Western part the values are very small, while in the Eastern (Santorini, Amorgos, Anafi islands) they are higher and locally around Santorini very high (>4%), probably due to the volcanic activity.
- Silt/Clay : The highest values (>4) are in the surrounding area of Santorini island.
- Quartz : High values occur Southernly of Sikinos and Ios. The highest ones in the area between Santorini and Anafi (>20%).
- Biogenics : The values have a uniform distribution between 20%-60% and particularly 80%.
- Iron Hydroxides : They appear in the area between Santorini and Anafi with concentration values >8% , probably due, again, to the volcanic activity.
- Carbonates : They have a normal distribution all over the studied area with values 20%-80%.
- Igneous Rocks : There are high concentration values in the Southern part of the studied area. The highest values appear among the islands Santorini, Anafi and Amorgos islands.





Foreland tectonics in the Southern Adriatic Sea

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The deformational patterns of the Adriatic area register the complex history of a changing geodynamic environment from a Mesozoic passive margin to a present-day foreland.

With the aid of newly acquired and the available multi-channel seismic reflection data tied in with wells in the public domain, gravity and magnetics we attempt to reconstruct the stratigraphic and structural evolution of the foreland region surrounding the Gargano Promontory. Particular attention is payed to the deformational styles, their temporal evolution and kinematic significance.

Two regional structural belts occur offshore the Gargano promontory. These belts have different trends and different ages of activity in the Tertiary and can also be linked to the recent seismicity recorded in the area.

Their structural style, combined with the stratigraphic relationships existing in the area, suggests that their origin can be linked to inversion tectonics processes affecting a Mesozoic extensional fault system. The timing of inversion appears to be related to the major tectonic pulses occurring in the adjacent fold-and-thrust belts (Dinarides and Apennines). The tectonic loading of these chains and the ensuing propagation of their peripheral bulges are major controls on the structural style of this foreland area.

G

Record of relative sea level rise on the Southern Adriatic Shelf

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A study carried out on 3.5 kHz Subbottom Profiles (SBP) highlights the fine stratigraphic architecture of the Southern Adriatic shelf. The area investigated is the only part of the broad and shallow Adriatic Sea where the shelf is facing a slope that goes to over 1000 m depth.

After a phase of margin outbuilding, marked by prodrading slope clinoforms, terminated by exposure and erosion over large part of the shelfal area, the sediments were mainly stored onto the shelf due to the ensuing relative sea level (RSL) rise.

The stratigraphic record of this RSL rise is well documented in the SBP where it appears as a set of thin, roughly tabular, units stacked one on top of the other and progressively stepping landward. Each of these units is about 20 to 40 m thick and is bounded by erosional unconformities. The internal configuration displays oblique and sigmoidal reflections downlapping onto the lower boundary and abruptly truncated by the upper unconformity. Rapid lateral changes in acoustic facies and local erosions on the upper part of the foresets suggests that these units originated during a RSL fall that, however, never reached the shelf edge.

Given the overall retrogradational stacking pattern of the units, these episodes of RSL fall appear to punctuate a general trend of RSL rise. It is noteworthy that sediments deposited mainly, if not only, during these pulses of RSL falls.

G

Microseismic Investigations in the western Mediterranean Sea.

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During autumn 1991 a team of German, Spanish and Marocco scientists investigated on/offshore microseismic activity in the Alboran Sea, in the Gibraltar Strait and adjacent onshore regions (Fig. 1). This project was a joint venture involving the Institut für Geophysik, Universität Hamburg (FRG), who provided 40 seismic landstations (LOBS), 15 ocean-bottom-seismographs (OBS) and the german research vessel RV - VALDIVIA, the Centre National de Recherche, Marocco, the SNED, Marocco, the Instituto Geografico Nacional, Spain and the SECEG-SA, Spain.

Aim of the experiment was to record and locate microearthquakes, and, by correlating the seismic data with the tectonic model, to locate areas of high seismic risk and active deformations, also to define the driving forces behind deformations.

Taking the new crustal models, as resulted from the interpretation of our wide-angle reflection and refraction seismic profiles, which were an additional part of the investigations, and the method proposed by SHAPIRA (1983), the p-wave arrivals and their orientation will be used to calculate hypocentres and their times of origin.

First results will present, the tectonic implication will be discuss and the on/offshore seismic activity, its intensity and frequency will be shown.

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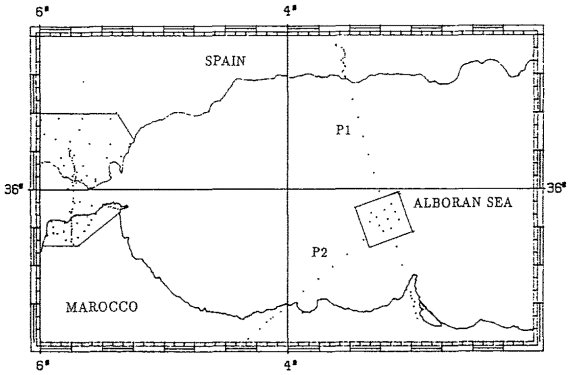

Fig. 1 : Location map of the on/offshore microseismic areas and the OBS/LOBS positions.

Mediterranean undercurrent contourites in the Gulf of Cadiz (Spain) : (II) Quaternary sediments and depositional processes

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In the Gulf of Cadiz there is a significant development of bottom-current deposits because the outflowing of the Mediterranean Undercurrent, shears along the Cadiz continental slope on its way from Gibraltar Strait. The sediment distribution pattern along the slope is a consequence of the interaction between the dense, saline Mediterranean water outflow, and the irregular bathymetry resulting from an unusually complex tectonic setting. Variations in current speed of the Mediterranean Undercurrent affect the distribution of surficial sediment and the type and size of seafloor bedforms (NELSON *et al*, in press).

The presence of the Mediterranean Undercurrent impinging on the seafloor below 300 m water depth controls the sediment dispersal on the upper slope, whereas the presence of two smooth terraces on the middle slope, and abrupt diapiric ridges and steep valleys in the central area, control the sediment dispersal in deeper areas. On the upcurrent slope terrace and along the upper slope, a tongue-like surficial deposit develops parallel to the general SE-NW bathymetric contours (Fig. 1). In this contourite deposit there is a clear gradation from medium-fine sand beds interbedded with mud close to the Gibraltar strait, changing northwestward to coarse silt beds. Immediately to the west near the Faro Drift off Portugal, the second downcurrent terrace on the middle slope is mostly covered by finegrained, silty-clayey deposits interbedded with biogenous sands. Lithology of the contourite sediment drift bodies banked against the diapiric ridges also varies from fine sand on the SE to sandy silt on the central ridge and valley area, and silt in the NW area.

On the middle to lower slope, the sediment distribution pattern is complex in the ridge and valley area where the Undercurrent flows down valley with higher current speeds and is locally erosive or depositional. Because of the Mediterranean Undercurrent shows both contour-parallel and valley perpendicular flow, the coarse-grained sediment of valley facies trends perpendicular to the small-scale bedforms and the finer-grained contourite deposits of adjacent sediment drift facies. Gravelly, shelly, coarse to medium sand lag deposits that are transported from the outer shelf and upper slope by high-energy processes, form on valley floors. The margins of eastern valleys are covered by sand dune deposits, whereas western channels are covered by sandy to clayey silt.

Similar to the surface texture, the composition of the sand fraction in the surface sediment also varies from SE to NW and from valley floor to intervalley areas and slope terraces. The central and SE valley floors contain mostly bioclastic debris, and a low content of planktonic constituents is found in the SE and upper slope regions. However, high quantities of planktonic constituents, mostly foraminiferal tests, are found in the sand fraction of the contourite deposits in the NW area.

Lithology of the upper 2 meters of sediment consist of sandy contourite layers interbedded with mottled, silty contourites, and hemipelagic silty clays, the coarser sand layers and the greater variations in grain-size occur on the SE sector. Along the slope there is a surficial sandy contourite layer between 0.2-1.2 m thick; this layer formed during the present Holocene high sea level that results in maximum water depth over the Gibraltar sill and full development of the Mediterranean Undercurrent. In some locations a second sandy contourite layer was recovered, having the same general SE to NW gradations as the upper layer. Both valley and contourite deposits are characterized by reverse graded bedding and sharp upper bed contacts in coarse-grained layers, low deposition rate and a regional pattern of textural variation and compositional gradation. Cores from the slope areas show sedimentary structures, through cross lamination, flat lamination or massive bedding within the contourite layers, but these structures do not occur in any vertical sequence. The typical reverse grading in sediment texture of the contourite layers indicates that with rising sea level and increasing Gibraltar sill cross-sectional area of water flow, the Mediterranean Undercurrent strength has gradually increased throughout the Holocene. Since the origin of the contourite sequence the rates of deposition have been low on the upper slope (<5 cm/1000 yr) and higher in the middle slope sediment drift (>13cm/1000 yr).

The late Pleistocene age of the mud underlying the surface sand sheet correlates with the age of the last sea-level lowstand and apparent weak Mediterranean Undercurrent development. The initial control on the sandy contourites system of the Gulf of Cadiz slope has been the opening of the Strait of Gibraltar at the beginning of the Pliocene.

Since that opening, high sea level equivalent to present or greater water depth over the Gibraltar sill has permitted circulation through the Strait and the development of a strong Mediterranean Undercurrent.

Thus the cyclic deposition of sand or mud layers and contourite or hemipelagic drape sequences appears to be related to late Pliocene and Quaternary sea level changes and Mediterranean water circulation patterns.

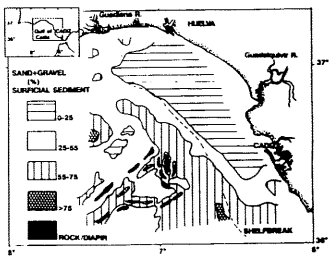

Figure 1. Textural map (% sand + gravel) of surficial sediment from the Gulf of Cadiz continental shelf and slope (modified from NELSON *et al*, in press).

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Mise en évidence de rythmes pluriannuels d'évolution côtière dans le Golfe du Lion (France)

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Sur les côtes sableuses, en mer microtidale, l'équilibre du trait de côte est assuré par une alimentation en matériel sédimentaire issu des bassins-versants qui transite le long de la côte à l'intérieur d'une étroite bande comprenant, non seulement la plage, mais tout le profil actif, du sommet du cordon dunaire aux fonds de 10 à 20m selon les cas. Le rôle de l'avant-côte est particulièrement sensible. Le rythme des échanges obéit à des logiques diverses inscrites dans des échelles de temps variées ("coups de mer", saisons, périodicités pluriannuelles,...).

Beaucoup de côtes à régime microtidal sont caractérisées par l'existence de reliefs linéaires sableux, plus ou moins parallèles au rivage : les barres d'avant-côte (BARUSSEAU et SAINT-GUILY, 1981). Elles jouent, dans ce système, un rôle notable dans le stockage et la disponibilité du matériel échangé avec la plage.

L'étude du profil transversal et le suivi de son évolution dans des zones soigneusement choisies constitue donc un accès privilégié pour la compréhension du fonctionnement des échanges qui concourent au bilan - négatif, équilibré ou positif - de l'avant-côte. Plusieurs conditions doivent toutefois présider à toute recherche de ce type. Il faut :

- compte-tenu d'une importante variabilité 3D (BARUSSEAU *et al.*, 1991), assurer un positionnement de grande précision,
- obtenir des mesures de très bonne qualité dans l'ensemble des disciplines mises en cause : océanographie physique côtière, sédimentologie et morphologie,
- opérer avec régularité pendant des périodes pluriannuelles.

Ces conditions ont conduit à mettre en oeuvre une méthodologie adaptée qu'on a appliqué à 2 sites du lido de l'étang de Thau. Des levés topobathymétriques ont été réalisés, depuis mai 1989, avec une fréquence presque mensuelle, en fonction des conditions météorologiques. Ils ont été accompagnés de 2 missions photographiques aériennes. Des prélèvements sédimentologiques, soigneusement positionnés sur les différents étages morpho-bathymétriques, ont été réalisés, de 1989 à 1992, pendant 6 périodes représentatives des conditions post-hivernales (missions de printemps) et post-estivales (missions d'automne). En outre, on a cherché à aborder de manière globale la définition des conditions océanographiques en récupérant toutes les données utilisables fournies par le satellite GEOSAT jusqu'à la fin de sa carrière opérationnelle et en recensant les données de Météo-France provenant des sémaphores de Sète et de Cap Béar et des navires sélectionnés. Le programme continuera avec le satellite ERS1.

Les principaux résultats concernent l'évolution morpho-sédimentaire. Les changements morphologiques enregistrés dans les deux observatoires montrent une réponse identique sous l'action des conditions océanographiques générales selon un rythme dont la composante saisonnière est loin d'être dominante. L'empreinte la plus durable est plutôt fournie par des maximums énergétiques courts et localisés dans le temps à l'échelle de plusieurs années. Cependant, l'identité des facteurs généraux du milieu n'empêche pas l'existence de disparités importantes entre les deux sites : nombre et position des barres d'avant-côte, type d'évolution (accrétion à la côte à Sète), schéma de circulation littorale. On peut finalement retenir quatre idées :

- les changements importants (par exemple, ceux qui font passer d'une morphologie différenciée à un relief moins marqué de la barre, ou inversement) sont rapides (quelques jours à quelques semaines),
- les périodes pendant lesquelles la morphologie est peu contrastée sont aussi des intervalles de faible remaniement,
- la formation de barre(s) bien distincte(s) s'accompagne de mouvements sédimentaires plus amples, impliquant des réajustements permanents,
- l'instabilité sédimentaire est favorisée par l'existence de pentes fortes, à l'issue des périodes de forte agitation.

L'emploi de la formulation empirique de QUELENNEC (1984) indique que le secteur de Sète se situe dans le champ d'équilibre mais avec une tendance marquée vers l'instabilité par érosion tandis que celui de Marseillan est en équilibre pour la barre externe et tend vers une situation d'engraissement pour la partie interne du profil.

L'analyse sédimentologique de matériaux principalement unimodaux peut être poussée jusqu'à l'emploi de 3 indices de forme. Les sables présentent des caractères bien définis à l'issue de la période de forte énergie (hiver 88-89) rencontrée au début de l'étude. Pendant les 28 mois qui font suite, le matériel acquiert peu à peu une plus grande diversité. On retrouve la subordination du déterminisme saisonnier à l'empreinte plus durable des rythmes pluriannuels. Cette conclusion est également supportée par l'analyse des fractions mobilisées à chaque étage morphobathymétrique.

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G

Canyons, chenaux profonds et appareils détritiques provençaux et corses, après les campagnes Mesea I et Mesea II (Mesim)

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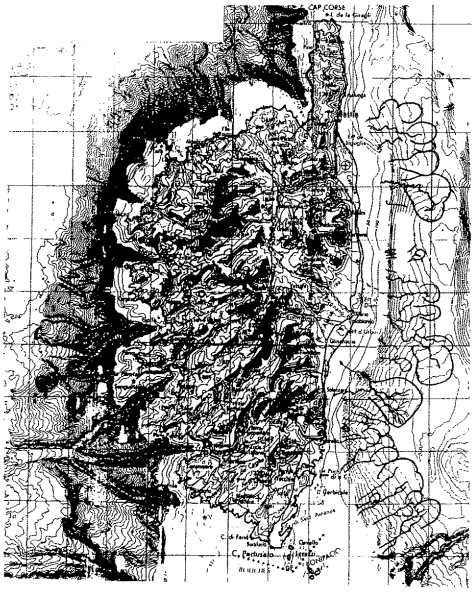
En l'espace de deux années, deux campagnes océanographiques entreprises dans le cadre du programme national de reconnaissance des zones économiques de l'Ifremer, ont permis de compléter entièrement la couverture bathymétrique détaillée au sondeur multifaisceaux et sismique des marges continentales provençale et corse. La première s'est déroulée en 1990 à bord du Jean Charcot et au moyen du Seabeam, la seconde, en 1991, à bord de l'Atalante et au moyen du Simrad EM12.

Les résultats acquis font l'objet d'un travail de cartographie systématique au centre Ifremer de Brest (cf. G.PAUTOT et G.BELLAICHE, ibid). Ils permettent en premier lieu de compléter et de préciser de façon notable nos connaissances sur la morphostructure de ces marges et notamment sur les appareils sédimentaires de bas de pente. Ainsi, la précision des sondages, permet de pouvoir rattacher désormais sans ambiguïté ces appareils à leurs canyons vecteurs respectifs et à leurs différentes sources d'alimentation terrigène. Ces résultats fournissent également des données nouvelles, notamment sur les marges corses, dont les caractères dissymétriques sont nettement mis en évidence. Alors que la marge occidentale de cette île présente des caractères très voisins de sa partie conjuguée provençale, sa marge orientale se particularise par la présence, dès le rebord de la plateforme, d'un très grand nombre de petits appareils détritiques particulièrement actifs, intensément ravinés, isolés ou coalescents, en relation parfois directe avec le vigoureux réseau hydrographique continental. Au niveau des bouches de Bonifacio, les mouvements tectoniques qui ont présidé à l'ouverture de la mer Tyrrhénienne commencent à se faire sentir, comme en témoigne le cours segmenté des canyons de ce secteur méridional.



1- Outre les auteurs cités, l'équipe scientifique embarquée au cours de ces deux campagnes comprenait notamment J. R. Vanney, A. Coutelle, J.C. Aloisi, C. de Giovanni, J.P.Rehault, J.Deverchere, J.P.. Maze et S. Monti.

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Saline minerals of the Tuzla salt deposit as indicators of Paleooceanographic conditions

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The Tuzla rock salt deposit in the central part of Bosnia and Herzegovina (Yugoslavia) comprises the principal salt body of the Tusanj hill area, and the recently discovered Tetima salt-stock lense. The salt-dome type deposit is largely stratified and is hosted in a Miocene-age sedimentary formation consisting primarily of banded marls with anhydrite. The salt bearing sedimentary sequence belongs to the Majevica mountain range horst, a prominent feature of a Miocene sea archipelago. Inspite of earlier detailed investigations of the salt deposit, there exist as yet no unequivocal evidence regarding the geological origin of this formation. This is mostly due to the fact that event lake basins such as the Tuzla area have an inherently low preservation potential for the geological record (HUTCHINSON, 1957). However, recent studies of trace element distributions in an assemblage of lithotype indicator minerals imply a possible complex marine type or mixing-zone depositional model of the evaporite formation (KNIEWALD *et al.* 1986; BRAJKOVIC *et al.* 1988).

The term "saline mineral" as used in this study refers to all minerals associated with the principal evaporite series. Most of these satisfy the condition of having sodium in one or all of their cation sites, with the carbonate anionic group supplying all or part of the negative charge. Other accessory minerals, such as the iron sulphide group minerals, are also treated here due to their close association with some minerals of the "saline" suite.

Principal minerals

The principal mineral paragenesis of the evaporite series consists of halite, thenardite and anhydrite, the a(H_2O) indicator pair (cf. BRAITSCH, 1971) being thenardite-mirabilite. The other classic indicator pair gaylussite-pirssonite is missing entirely from this assemblage.

Accessory minerals

Apart from the three principal minerals, the evaporite series assemblage contains also a number of accessory (supporting) minerals present occasionally in trace quantities. These are bradleyite, glauberite, huntite, mirabilite, nahcolite, northupite and ferronorthupite, probertite, searlesite, teepleite and trona. Iron sulphides are closely associated with northupite, and are in some cases enclosed within crystals or globules of this mineral. The northupite-ferronorthupite couple is highly sensitive to prevailing conditions of redox potential (Eh), either during the time of initial deposition or in the course of diagenesis. Dolomitic limestones are found closely related to evaporite beds. Evidence of progressive dolomitization involves the calcite-huntite-dolomite equilibria and may account for their formation under evaporative, nonevaporative or seepage reflux.

The depositional milieu of the saline mineral suite can be analysed and interpreted in terms of the following matrix of environmental parameters (adapted from KELTS, 1988):

HYDROLOGY	FACIES	CONCENTRATION	IONIC COMPOSITION
Open Semi-closed Closed	Shallow Littoral Deep Pelagic	Dilute Oligosaline Mesosaline Saline Penesaline Hypersaline	acidic Ca, CO_3 Na, Mg Cl, SO_4 Na, HCO_3, CO_3 Mg, Ca, Cl

Even a preliminary analysis of the associate mineral assemblage indicates that the evaporite sequence and the hosting sedimentary series was probably formed in an environment of rapidly changing physico-chemical conditions ranging from a coastal marine setting to a shallow, hypersaline lacustrine brine. There is also evidence for periods of suboxic/anoxic and euxinic regimes, which corroborates the mixing-zone model for the formation of the Tuzla salt deposit.

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A late quaternary stratigraphic type-sequence in the Northern Nile Delta

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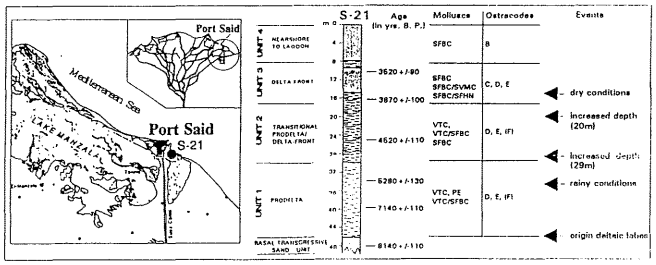
Introduction and purpose. The Nile Delta Project is a multi-disciplinary research program initiated at the Smithsonian's National Museum of Natural History in 1985. Its goal is the interpretation of geological and environmental changes which have affected the Nile Delta in Egypt over time (STANLEY, 1990). This can best be achieved by means of analysis of continuous subsurface core sections. Consequently, 87 borings have been recovered across the northern Delta during five expeditions, from 1985 to 1990. These borings range in lenght from 15 to 60 m., and comprise stratigraphic sections dated from about 35,000 years to the present. Special attention is being paid to the evolution of the northern Nile Delta during the past 10,000 years. In their focus on the northeastern Delta, BERNASCONI *et al.*, (1991) and PUGLIESE and STANLEY (1991) have selected boring S-21 as the most representative and complete stratigraphic sequence, displaying an entire progradational series from about 8,000-7,500 years B.P. to the present. This Holocene deltaic sequence is separated from underlying late Pleistocene sands by an unconformity; these sediments have been petrologically analyzed. From core-bottom to core-top, PUGLIESE and STANLEY (1991) recognize a progradational sequence which consists of prodelta (46-30 m), transitional prodelta/delta-front (30-17 m), delta-front (17-8 m), shallow nearshore bars, coastal ridges, and lagoon (8 m-core top) facies.

Faunae. Most mollusc and ostracode species recovered and identified in boring S-21 live in modern Mediterranean deltaic-related settings. Taking this into consideration, one can apply modern environmental data to the study of this deltaic sequence. Molluscs are clustered by BERNASCONI *et al.*, (1991) in different fossil communities, comparable to several modern Mediterranean biocoenoses and/or ecotones (*sensu* PERES and PICARD, 1964). Of note, two major paleobiocoenoses are recognized, i.e. VTC (Terrigenous Mud Biocoenosis) and SFBC (Fine Well Sorted Sands Biocoenosis). Several subordinate fossil communities are also present: PE (Heterogeneous Community), and transitional VTC/SFBC, SFBC/SVMC (Superficial Muddy Sand in Sheltered Areas Biocoenosis), and SFBC/SFHN (Superficial Fine Sand Biocoenosis). PUGLIESE and STANLEY (1991) highlighted 6 (A-F) groups of ostracode species as markers of well-defined deltaic settings. Group A corresponds to fresh-water species; Group B to brackish-water species; Group C to marine nearshore (normally with vegetation) species; Group D to marine nearshore without vegetal meadow species; Group E to marine nearshore with vegetal meadow/open marine, with or without vegetal meadow species; Group F to open marine species. Group A is represented by displaced specimens only. Another Group (M=miscellaneous) is represented only by allochthonous marine and brackish water juveniles.

Interpretation and conclusions. On the basis of the above letter-coded faunae and their related settings, four units have been identified in boring S-21, from bottom to top :

- Unit 1 (46-30 m), silty clays with VTC, PE, VTC/SFBC mollusc communities and ostracodes of groups D, E, and, subordinately, F characterize prodelta settings;
- Unit 2 (30-17 m), clayey silts with the same above ostracode faunae and VTC, VTC/SFBC and SFBC molluscs indicate transitional prodelta/delta-front settings;
- Unit 3 (17-8 m), sands and interbedded clayey silts with ostracodes of groups C, D and E, and SFBC mollusc community denote delta-front facies;
- Unit 4 (8 m to core-top), sands with very rare mollusc SFBC communities and ostracodes of Group B, sometimes with displaced juveniles of marine species, indicate nearshore to lagoon settings.

Environmental interpretation of the units 1 and 2 is based mainly on petrological data, since the fossil assemblages are quite similar in both units. However, two observations can be made on the basis of fossils : 1) ostracodes of Group F associated with the VTC molluscan biocoenosis at core depths of 29 and 20 m indicate episodes of increased depth during this period; 2) the exclusive presence of ostracodes of Group E in some core intervals indicates vegetaded seafloors. In Unit 3, at about 13 m core depth, the combined presence of C, D, E ostracodes, and SFBC mollusc paleocommunity indicate clayey silty vegetated seafloors of proximal delta-front. Overlying sands with SFBC and SFBC/SFHN mollusc communities and only allochthonous juvenile valves of ostracodes characterize seafloors close to a river mouth. In Unit 4, lagoonal settings are easily recognizable at the core-top by the exclusive presence of the ostracode species *Cyprideis torosa* (Group B), which can also tolerate extreme evaporitic conditions. A sebhka environment is also suggested by the presence ot gypsum/halyte. Besides serving to refine the environmental evolution, paleontological data shed light on geological/environmental and climatic events : since their origin (8,000-7,500 years B.P.) the deltaic lobes (probably of the Pelusiac branch of the Nile) display a constant coarsening-upward trend. Within the prodelta system, the progradational trend is interrupted twice, as indicated by the presence of VTC molluscs an F ostracodes. These forms could record two episodes of increased water depth. The first one (at about 29m) may correlate with the sea-ingression occurring at about 5,000 years B.P. (SUMMERHAYES *et al.*, 1978; COUTELLIER and STANLEY, 1987). - Climatic changes may also be recorded by ostracodes. Extensive continental run-off probably occurred about 5,700-5,500 years B.P., as suggested by frequent findings of displaced fresh and brackish-water ostracodes in marine assemblages. This may be related to increased rainy conditions. About 4,000 years B.P., an ostracode species *Sylvestra* sp. 1 disappeared. This taxon belongs to a genus which lives in the Red Sea but is presently absent in the modern Mediterranean Sea. This disappearance corresponds to a climatic change from wet to dry conditions as documented by ADAMSON *et al.*, (1980).



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Importance des rides littorales sableuses dans les systèmes dynamiques côtiers

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L'analyse des rides littorales et cardons festonnés, pour le secteur compris entre le Grau-du-Roi et Fréjus, souligne l'importance de ces corps sédimentaires vis à vis de l'évolution des rivages ainsi que des modalités concernant les flux sédimentaires.

Or ces constructions (longshore bars, crescentic bars) bordent, en nombre variable, des littoraux à régimes divers : sédimentation active, état d'équilibre relatif ou érosion forte ou modérée.

Origines

Les rides sont localisées aux zones de déferlements à "haute énergie", très exposées aux vents et ondes incidentes. Elles correspondent fréquemment à des nodales d'interférences pour des oscillations à fréquences variables, d'où leur structure périodique.

Dynamique

Cette dernière est induite par l'extension des zones de déferlement vers le large, par gros temps, en fonction des houles significatives (H 1/3 sup.) et du tracé des longshore-currents. Plusieurs types de forces peuvent être identifiés :

- ondes à hautes fréquences, à spectre complexe : vagues obliques et déferlantes dépendant d'impacts météorologiques et de fronts aux golfes de Gênes et du Lion. En sites exposés, on relève des "pics" de fréquences liés aux distances de fetch et aux fluctuations des vents dominants (vitesses et azimuts). D'où l'origine probable des micro-cycles observés à la zone du swash.

Dans ce cadre, interviennent la présence d'obstacles, les résonances et réflexions, les déplacements de la "zone neutre". La formation de beach-cusps et l'établissement du système des rides internes (1 ère et 2 éme rides) en seraient les conséquences.

- ondes à basses fréquences : spectre des tempêtes exceptionnelles, annuelles ou pluriannuelles ("infragravity edge waves") accompagnées de submersions temporaires, sinuosités à grande échelle du rivage sableux et système des rides et mégarides externes (λ comprises entre 400 et 1800 m).

Pour le cas des littoraux considérés, à régime microtidal, les systèmes de rides sont interrompus par le fonctionnement de courants sagittaux dont le nombre peut s'accroître avec le temps sur un rivage menacé (Camargue).

Les structures altérées peuvent être reconstruites, modifiées par la coalescence de corps sédimentaires sigmoïdaux. la perte en sédiment peut être compensée par l'apparition de nodales nouvelles, adaptées au profil et se relayant au large. La disparition ou l'amaigrissement prolongé des "long-shore bars" peut aboutir à des situations dangereuses.

On peut déceler certaines corrélations entre les variables étudiées : les régressions multiples, l'analyse des variables "pas à pas" mettent en évidence trois faits :

1. originalité du système propre aux rides les plus externes corrélées aux ondes longues des tempêtes (flux à basses fréquences),
2. tendance vers des états relativement stables lorsque se développent des systèmes à 4, 5, 6 nodales, en des sites où l'on observe des flux convergents et des boucles de courants (golfe de Beauduc),
3. situations dangereuses lors des fortes surélévations du niveau avec une augmentation du nombre de chenaux de "rip-currents", la modification ou la destruction des rides internes.

Les facteurs confirmés par l'analyse factorielle (données codées, centrées-réduites) permettent de dégager les influences suivantes :

1 : ondes à basses fréquences : sinuosités à grande échelle au littoral et aux corps sableux externes (mégarides),

2 : taux de sédimentation obtenus par l'examen de profils de références,

3 : déficits sédimentaires aggravés par la dispersion au large (ondes obliques à forte cambrure, courants sagittaux)

L'analyse hiérarchique, basée sur les distances du X 2, permet une discrimination des sites exposés et une classification automatique des profils à rides littorales. On distingue :

1 : profils stables, à taux de sédimentation faible. Les seules érosions temporaires sont dues à des impacts météorologiques,

2 : zones en voie de colmatage. La sédimentation active y est induite par la présence de nodales multiples et de flux convergents,

3 : rivages menacés et secteurs à submersion temporaire : chenaux de "rip-currents" en réseau dense, surélévations fortes et brèves, système de rides modifié ou érodé.

Le problème est actuellement accru par une actuelle remontée du niveau de la mer aux taux moyen de 1,3 mm/an, très sensible à court terme sur les littoraux très bas.

Les rides littorales et les cordons festonnés s'intégrent dans un système dynamique complexe où les évolutions des flux et des stocks conduisent à des états diversifiés, conséquences du bilan sédimentaire global déficitaire des plages et de l'action des micro-climats locaux.

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Adriatic hydrographic changes since 17 000 yrs as recorded by bioevents and foraminiferal stable isotopes

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It is becoming increasingly clear that variations in physical parameters of the sea water in conjunction with variations in the kind and availability of prey are major driving forces accounting for planktonic foraminiferal occurrences and abundances. The 8 ecozonations which have been identified within the last deglacial time interval in the Adriatic Sea (BORSETTI *et al*, this volume) invoke important hydrological changes. On the basis of these zonations, we propose the following hydrographic scenarios.

During the time interval corresponding to ecozone 8, the global sea level rise was rather weak (FAIRBANKS, 1989). Poorly stratified and cool waters still favoured the permanency of deep living species like *Globorotalia scitula* as well as other "cold" indicator species.

The successive ecozone 7 corresponds to the first deglacial freshwater discharge in the Adriatic and to an important global sea level rise. This situation may have induced a significant density stratification with nutrient rich waters from continental origin invading part of the basin. The surface production increased, favouring diatom blooms and foraminiferal species predating on them, such as *Globorotalia truncatulinoides*. The shoaling of the pycnocline and the formation of a deep chlorophyll maximum favoured the presence of abundant dextral *Neogloboquadrina pachyderma*.

Ecozone 6 corresponds to the classical Younger Dryas pause. In the Adriatic Sea, this climatic event appears strongly marked. The oxygen isotope record indicates that during this time interval freshwater discharges completely ceased. The permanency of Neogloboquadrinids however suggest that a deep chlorophyll maximum was still present. This may be explained by the fact that at that time, the Northern Hemisphere insolation reached its maximum at mid latitudes. The related seasonal stratification invoked the formation of a deep chlorophyll maximum.

Ecozone 5 corresponds to the beginning of the more recent fresh water discharge. Nutrient rich waters invaded again the Adriatic basin inducing an important surficial production, as suggested by the occurrence of foraminiferal species which predate on phytoplancton.This fact may have been associated with a seasonal shoaling of the thermocline, as suggested by the first entry of levantine species.

Ecozone 4 is marked by a rather important oligotrophism of surface waters. Only carnivorous foraminiferal species such as *Globigerinoides ruber ruber, Orbulina universa, Globigerina calida* and *Globigerina digitata* are dominant. The stratification of the water masses reached its maximum. Superimposed to the freshwater discharges, important precipitations may have occurred in the northern part of the Mediterranean basin . This in turn induced a strong salinity decrease, which prevented deep water formation in the Adriatic basin. This episod corresponds in fact to the deposition of Sapropel S1 in the Eastern Mediterranean and of low oxygenated levels in the South Adriatic basin.

During the time interval corresponding to ecozone 3, foraminiferal oxygen isotope data record a decrease in the freshwater discharge. The reappearance of species related to a deep chlorophyll maximum (*Neogloboquadrina pachyderma*) together with the last occurrence, in the Adriatic, of *Globorotalia inflata*, indicates a strong seasonal contrast with deep winter vertical mixing followed by the occurrence of a shallow pycnocline during intermediate season.

Ecozone 2 indicates important changes in the depth of the mixed layer. A good reoxygenation of the water column is supported by the presence of well diversified benthic associations.

Ecozone 1 corresponds to the present day hydrographic situation, withl a clear seasonal surficial oligotrophism.

The data, on their whole, suggest that foraminiferal associations with strong western affinities prevailed within the Adriatic basin throughout the entire deglaciation, until about 9.5 kyrs. After these date, they were replaced by species with clear levantine affinities which still dominate the present day association.

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High resolution biochronology for the last deglacial period in the Adriatic sea, based on planktonic foraminiferal associations and oxygen isotope stratigraphy

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Biostratigraphic events

Five major biostratigraphic events have been recognized in the Adriatic sea for the last 17000 years. High resolution oxygen isotope stratigraphy on four selected cores, IN68-5, 9, 10 and 21 together with ^{14}C radiocarbon and AMS datings, allow us to date these events precisely as follows :

-Last occurrence of *Globorotalia scitula*, dated at about 13.5 kyrs BP;

-First strong reduction in dextral *Neogloboquadrina pachyderma* percentages, dated at about 10 kyrs BP;

-Last occurrence of *Globorotalia inflata* around 5 kyrs BP;

-Last occurrence of *Globorotalia truncatulinoides* at about 9.5 kyrs BP;

-Abrupt entry of the warm species association: *Globigerinoides ruber ruber, Globigerina calida ,Globigerina digitata*, at about 9 kyrs BP.

Local Adriatic Biozonation

On the basis of these major events, of quantitative changes in the abundances of some species as well as of temporary disappearances or reappearances, the following eight biozones can be identified :

- Biozone 8, up to 13.5 kyrs BP : the top of this zone is defined by the last occurrence of *Globorotalia scitula* and a strong increase in dextral *Neogloboquadrina pachyderma* percentages from about 20% to 40%. The association is almost completely constituted by "cold species" whereas *Globigerinoides ruber* group and *Neogloboquadrina dutertrei* are present with very low percentages.
- Biozone 7, from 13.5 to 11.5 kyrs BP : this zone is characterized by an increase in the percentages of the *Globigerinoides ruber* group and *Globorotalia inflata* (near 10%) and by the occurrence of *Globorotalia truncatulinoides* at very low percentages.
- Biozone 6, from 11.5 kyrs to 10 kyrs BP : in this zone, the *Globigerinoides ruber* group is completely lacking, *Neogloboquadrina dutertrei* generally occurs with percentages around 5%. The top of this zone is marked by the abrupt reduction in *Neogloboquadrina pachyderma* percentages.
- Biozone 5, from about 10 kyrs to 9 kyrs BP : this zone is characterized by the reappearance of *Globorotalia inflata* and of the *Globigerinoides ruber* group and by a brief and last occurrence of *Globorotalia truncatulinoides*. In this biozone, we have also the first occurrence of the "warm" species *Globigerina calida* and *Globigerina praecalida* .
- Biozone 4, from 9 kyrs to 8 kyrs BP : this zone is easily recognized by the high frequencies of "warm" species such as *Globigerinoides ruber ruber, Orbulina universa, Globigerina calida,* and *Globigerina digitata* which can account for 70 to 80 % of the whole association. *Globigerina bulloides* and *Globigerina quinqueloba* are also present . In the same interval one can also note that radiolarians and diatoms can be present while benthic foraminifers are absent.
- Biozone 3, from about 8 kyrs to 6.5 kyrs BP: this zone is characterized by the last occurrences of *Globorotalia inflata* and dextral *Neogloboquadrina pachyderma* in the Adriatic Sea with total percentages around 20%.
- Biozone 2, from 6.5 to 5. kyrs BP : this interval is characterized by the relative high frequencies of *Globigerinoides ruber ruber, Globigerinoides trilobus* and *Globigerinoides sacculifer*. The benthic foraminiferal associations is also rich and well diversified.
- Biozone 1, from 5 kyrs BP to the present : this zone is characterized by the modern association of "warm" species such as *Globigerinoides ruber* group, *Globigerinoides trilobus, Globigerinoides sacculifer*, low frequency of *Globigerina praecalida, Globigerina bulloides and Globigerina quinqueloba* are also present.

This ecozonation is different from those observed in other West and East Mediterranean areas. The time distribution of many species does not appear to be linked to surface temperature changes alone : this is the case for *Globorotalia truncatulinloides* or dextral *Neogloboquadrina pachyderma*, which may occur either during the earlier cold phase of the deglaciation or during the Holocene. This underlines the fact that hydrographic changes as well as eustatic and tectonic sea level changes are important forcing parameters for the biological components.

Planktonic Foraminiferal Biocronology during the last 127000 years in the Thyrrenian Sea

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The study of 21 cores, collected in different morphology units (perithyrrenian basins, abissal plane and seamounts) evidenced the great complexity of the paleoceanography in this area. The difficulty in identify the local answer to the climatic global changes during the past 127000 yr B.P. is due to the sedimentological setting and to the local microclimes induced by the geomorphology of the area and of its margins. Nevertheless sequences of biostratigraphic events common to entire Thyrrenian sea has been recognized by a local occurrence, or by a significant increase (or decrease) in the percentages of planktonic Foraminiferal species.

On the base of major faunal changes we have identifyed for the last 127000 yrs B.P. 8 ecozones defined as follow :

8 - very tipical interval characterized by presence of *Globigerinoides conglobatus* with a temperate water assemblage (*Globorotalia inflata, Globorotalia truncatulinoides, Globigerinoides ruber group*);

7 - the total fauna is constituite by "cold species": *Globigerina bulloides, Globorotalia scitula* and *Neogloboquadrina pachyderma;*

6 - persistence of "cold species", presence of *Globorotalia inflata* and increasing in the lower part of this interval of *Globorotalia truncatulinoides;*

5 - *Globigerina bulloides, Globigerina quinqueloba, Neogloboquadrina pachyderma* and *Globorotalia scitula* are dominant species; *G. glutinata* is present in low percentages (10 %). Small and compact species of *Globigerinoides ruber* are present in 2 separated peaks (at about 10-15 %);

4 - in this long interval *Globorotalia scitula* and *Neogloboquadrina pachyderma* are present in percentage at about 20 %; *Globorotalia truncatulinoides, Globorotalia inflata* and *Globigerinoides ruber* decrease in the central part of the interval in coincidence of a positive peak of *Globigerina bulloides;*

3 - this ecozone is defined by a peak value in the "warm species": *Globigerina praecalida, Globigerina calida, Globigerina praedigitata, Globigerina digitata* and *Hastigerina siphonifera;*

2 - very short interval characterized by a relative increasing of *Globigerinoides trilobus* and *Globigerinoides saeculifer*, slight increase of *Globigerinoides ruber;*

1- hight frequences of *Globigerina bulloides, Globigerina quinqueloba, Globorotalia inflata, Globorotalia truncatulinoides, Globigerinoides ruber* group and low percentages (5 %) of *Globigerinita glutinata.* High resolution oxygen isotope stratigraphy on four selected cores, allow to date the 8 ecozones as follows :

ecozone 8 - correspond to the isotopic stage 5 and range from 127000 ys B.P. to 78000 yr B.P. ;

ecozone 7 - cold interval between 78000 yr B.P. and the beginning of the last interstadial at 65000 yr B.P.;

ecozone 6 - it represent the last interstadial between 65000 yr B.P. and 28000 yr B.P.;

ecozone 5 - it is the coldest interval and correspond to the last glacial ranging from 28000 yr B.P. to 14000 yr B.P.;

ecozone 4 - this ecozone correspond to the last deglaciation from 14000 yr B.P.. In this interval the positive peak of *Globigerina bulloides* identifie the cold pause of deglaciation occurred around 11000-10000 yr B.P. (Younger Dryas);

ecozone 3 - the abundance of superficial warm association, tipical in this interval, is interpreted as the western record of the hidrological levantin situation, responsable of the deposition of sapropel Sl. Therefore it represents the time interval betwen 9000 and 8000 yr B.P.;

ecozone 2 - in this interval, the positive peak of the warm waters *Globigerinoides trilobus* and *Globigerinoides sacculifer* is correlated of the last Climatic Optimum occurred at about 5000-6000 yr B.P. The ecozone therefore ranges from 8 to 5000 yr B.P.;

ecozone I - it represents the present living association, started at about 5000 yr B.P.

Nouvel ensemble pour la reconnaissance du plateau continental : Sondeur multifaisceaux EM1000 et logiciel trismus un exemple : la Baie des Anges (France)

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L'Ifremer s'est doté en 1991 d'un sondeur multifaisceaux SIMRADEM 1000 produisant des données bathymétriques et d'imageries type sonar latéral. Il est opérationnel de 5 m. à 800 m. d'eau et couvre, à 8 ou 10 noeuds, un couloir de 700 (pour 100 m. de fond) à 1000 m. grâce à ses 48 ou 60 faisceaux suivant le mode de fonctionnement. Autour de cet outil, l'Ifremer a développé un puissant ensemble informatique pour assurer :

- les tâches temps réel comme la gestion des paramètres de navigation (CINNA), la visualisation en temps quasi réel de la bathymétrie ou d'autres paramètres géophysiques (VIDOSC) et l'archivage des données bathymétriques et d'imageries (ARCHIV),
- et les tâches temps différé (TRISMUS) réalisables à bord ou à terre comme le rejeu de la navigation, la correction d'attitude (pillonement, marée prédite ou observée, ...) et le traitement et la visualisation de la bathymétrie.

La première mission d'essai a eu lieu dans le secteur déjà connu (PAUTOT, 1981) de la Baie des Anges près de Nice. La géologie post-messinienne de cette zone comprend principalement une phase transgressive de dépôt de sédiments deltaïques pliocènes puis à partir du Pléistocène une phase érosive contrôlée par la tectonique et l'eustatisme (SAVOYE et PIPER, 1991) conduisant au modelé actuel. Les différentes analyses morphologiques (GUILLOCHEAU, 1983 ; BOURILLET, 1991) se sont appuyées sur la "Carte Bathymétrique de la Baie des Anges Nice-Côte d'azur" à l'échelle du 1/25.000 ème (PAUTOT, MONTI et CARRE, 1981), compilation de données du sondeur multi-faisceaux Sea-Beam pour les zones les plus profondes et de données de mono-faisceau pour la partie côtière.

La figure 1 montre une petite zone levée par le Sea-Beam puis compilée manuellement ; la figure 2 montre la même zone levée par l'EM1000 et traitée par le logiciel TRISMUS. Elle présente une "image plus vraie" du fond, en mettant en évidence les crêtes, les canyons et le chevelu des tributaires. Une comparaison plus poussée atteste du très bon positionnement de l'époque puisque les structures se superposent, mais l'EM1000 apporte de nouveaux détails.

Cet ensemble offre aux utilisateurs scientifiques ou industriels une précision tout à fait unique à condition de porter une attention particulière au positionnement pour les cartes à grande échelle (1/10.000ème et 1/5.000ème). De plus, des produits nouveaux, comme la superposition de l'imagerie sonar sur un modelé bathymétrique, sont atttendus.

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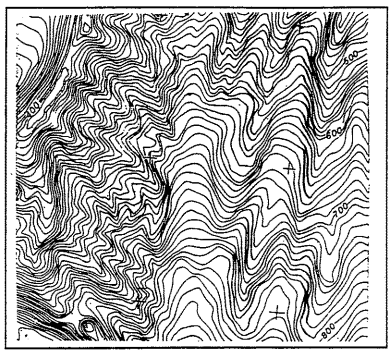

Figure 1 Carte Sea-Beam

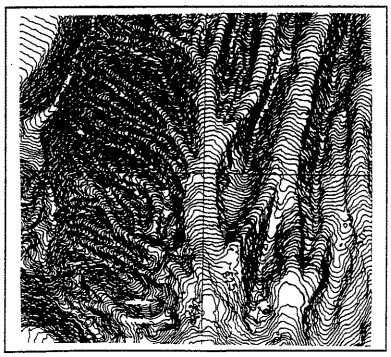

Figure 2 Carte EM1000

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L'utilisation de la Microscopie Electronique à Balayage pour l'étude morphoscopique et exoscopique des quartz appliquée à l'identification des environnements de paléo-plages. Recherches dans le secteur compris entre Capo Testa et Punta di li Francesi (Sardegna Septentrionale).

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Ce travail, basé sur la comparaison de grains de quartz provenant de dunes éoliennes, plages et beach-rocks, a pour objectif de vérifier si à partir de dépôts sédimentaires actuels facilement identifiables, il est possible de retrouver les signatures des environnements dans lesquels ont évolué les quartz appartenant aux lignes de rivage échantillonnées dans la zone comprise entre Capo Testa et Punta di li Francesi (beach-rocks) au cours de recherches qui se sont déroulées pendant les cinq dernières années (DeMURO et ULZEGA, 1988 ; DeMURO 1990, BRAMBATI et DeMURO, 1991).

Les informations fournies par l'étude exoscopique des quartz ont été directement enregistrées sur vidéo, dans le but de ne perdre aucune information. Les observations ont été effectuées également sur certains grains de feldspaths. Apres avoir été analysés en lames minces, les échantillons de beach-rock ont été désagrégés en grains et fragments pour l'étude aux microscopes binoculaire et électronique.

L' étude des lames minces a permis, grâce à l'analyse optique à la tablette compte-points, d'établir les pourcentages des différents minéraux.

En outre, une analyse morphologique des grains de quartz en microscopie électronique a été accomplie sur les échantillons désagrégés de beach-rock et grès wurmiens. Les grains de quartz ainsi obtenus ont été lavés dans l'eau distillée et essiqués en étuve à 40° C.

Généralement les observations s'effectuent sur grains de dimensions comprises entre 0,3 mm et 2 mm (CALLIEUX et TRICART, 1959). Ainsi les sédiments ont été séparés en trois fractions granulomètriques : inférieure à 0,5 mm, comprise entre 0,5 mm et 1 mm, et entre 1 mm et 2 mm. Les grains sélectionnés pour l'étude au microscope électronique à balayage (S.E.M Philips 515 et Cambridge 250 MK 2) ont été fixés sur des porte-échantillons en aluminium grâce à un scotch biadhesif et métallisés avec Or.

Au moins 25 grains ont été comptés pour chaque fraction granulomètrique. Les résultats ont été traduits en pourcentages de types de grains selon les classifications proposées par LE RIBAULT (1977). Deux comptages successifs ont été suffisants.

En suivant le raisonnement selon lequel chaque environnement est un système naturel soumis à des facteurs (mécaniques, physiques, chimiques, biologiques) qui le définissent, alors tels facteurs devraient influencer les minéraux jusqu'à changer leur caractère d'origine. L'ensemble des caractères morphologiques superficiels typiques du milieu dans lequel ils ont séjourné est défini comme phénomorphie.

Les observations (jusqu'à 10.000 agrandissements) effectuées sur chaque grain de quartz sélectionné, ont été classifiées en fonction de leur fréquence. Mais le but essentiel de ce travail demeure qualitatif et consiste à retrouver les indices typiques reconduisant à un environnement marin actuel.

Différents auteurs tentent actuellement de donner une interprétation de l'environnement aux observations d'exoscopie, basée sur un standard de classification des structures qui commence à être acceptée grâce aux très nombreux travaux effectués surtout sur les grains de quartz.

Il est nécessaire de faire un choix sur le type de traitement de l'échantillon, et ceci n'est pas toujours simple. Certains auteurs (WILLIAMS et THOMAS, 1989) utilisent la méthode de KRINSLEY et DOORNKAMP (1973), selon laquelle les grains de quartz sont lavés dans une solution d'acide chlorhydrique. Dans ce cas les structures peuvent apparaître beaucoup plus propres, nous sommes sûrs de nous trouver en présence de quartz pur, mais les épigénèses de nature carbonatée disparaissent totalement. KK

Dans ce travail nous avons donc préféré laver les échantillons de dunes et littoraux dans l'eau distillée .

Les beach-rocks par contre ont été attaqués avec l'acide chlorhydrique suivant la méthode de KRINSLEY.

L'avantage du système d'analyse chimique en Spectrométrie à Dispersion d'Energie (E.D.S) associé à un M.E.B, est de vérifier les éléments chimiques présents en chaque point de l'échantillon observé. Les quartz d'environnement sédimentaire actuel ont été étudiés (Dune-Littoral) dans le but de fournir un modèle de référence; ensuite les quartz appartenant aux formations wurmiennes et beach-rocks ont été étudiés pour comprendre dans quel environnement a évolué chaque grain.

Dans tous les cas, au moins 50 grains par échantillon ont été observés ; à 500 x pour une première exploration à caractère morphoscopique (forme, arrondissement, abrasion des bords et relief), et jusqu'à 10.000 x pour l'exoscopie.

Grâce à l'étude exoscopique des quartz, il a été ainsi possible de faire la distinction entre éolianites wurmiennes et beach-rocks. En effet, malgré les caractères morphoscopiques semblables, les premières présentent uniquement des structures oscopique tèmoignant d'un transport par voie éolienne, alors que les dernières semblent avoir évolué surtout en milieu littoral. Certaines structures observées sur les quartz des beach-rocks apparaissent comme le produit d'une évolution complexe (transport par voie éolienne précédant le séjour en milieu littoral). L'utilisation des techniques de morphoscopie et exoscopie des quartz a été extrêmement utile dans le but d'encadrer l'évolution sédimentologique et les environnements dépositionnels de certaines paleo-lignes de rivage submergées, individualisées et cartographiées en Sardaigne septentrionale.

Mots clefs : Sédimentologie, Géomorphologie côtière, Morphoscopie et Exoscopie, Microscopie Electronique, Lignes de rivages submergées, Quaternaire.

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Morphology and Seismostratigraphy of The Proximal Shelf between Capo Testa and Punta di li Francesi (Northern Sardinia) Preliminary results

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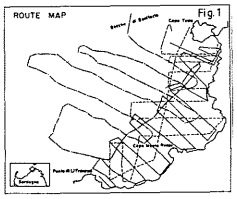
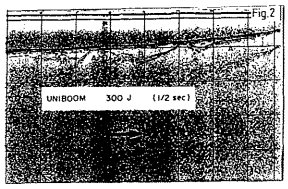
This paper presents the preliminary data extrapolated from the interpretation of S.B.P. (3.5 Khz) and Uniboom (300-500 J) profiles that were carried out during the Sardinia campaign 89/1 along that part of the Continental Shelf of Northern Sardinia stretching between Capo Testa and Punta di li Francesi (fig.1).





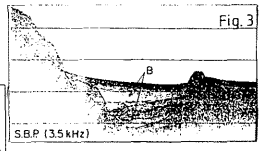
The emerged shoreline is characterized by different types of coherent rocks (granites and hercynite metamorphites, Miocene-raised limestone which are also to be found on the Continental Shelf, as shown in the S.B.P and Uniboom profiles through the analysis of their reflections. The Paleozoic basement produces very bright, sometimes hyperbolic reflections, and has irregular surfaces with no inner reflections, called non-reflective-basement. Both S.B.P and Uniboom profiles show a sedimentary facies (most probably Miocene) that gives a non-reflective-basement type response to S.B.P, while Uniboom profiles generally reveal a weakening of the signals and at times, depending on the orientation of the lines, even a few internal reflectors, which makes it possible to recognise the structure of a stratified body in certain stretches (fig. 2-3).

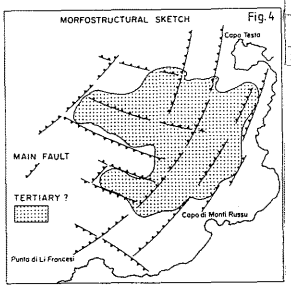
Incoherent Quaternary-raised deposits are patently visible in S.B.P profiles while they only rarely exceed the signal length with Uniboom.

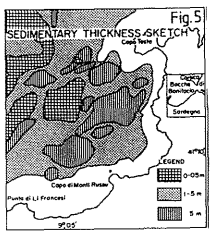
This method of analysis highlights the structural prisms and the sedimentary units (A and B). The Paleozoic basement of the submerged shoreline is characterised by the presence of local faults and fractures towards the NE-SW and NW-SE (fig.4). Because no sample of the sedimentary unit (which will be the object of future research campaigns) was available, its dating back to the Miocene can only be assumed at present, though there are numerous reasons supporting the assumption.

The Quaternary-raised units (Unit B) consist of seismically transparent sediments with proximal facies. Their location is parallel to the underlying regular surfaces while it is divergent on uneven surfaces. Width distribution depends on the morphology which is in a sense fossilized by this cover. Peaks and plains have only a thin superficial sediment film which tends to thicken in the incisions (fig.n 5).

These deposits form on average a 5-6 m thick layer upon the proximal shelf but become thicker offshore (cut-and-fill type relation).







Acknowledgment

Thanks to Dr. Luciano LECCA for his critical review of the manuscripts. Our great thanks go to Prof. A. ULZEGA for allowing the aquisition of the seismic lines during the Sardegna 89/1 cruise. Key words : Continental Shelf Geomorphology, Coastal Geomorphology, Seismostratigraphy, Northern Sardinia.

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Cyprus Basin: Evolution and Dispertion of Quaternary Sediments

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The Cyprus Basin is the eastern part of the Levantine Basin; in this area, sedimentation is mainly affected by the detrital supply from the Nile river and by the seasonal supply from minor rivers flowing in nearby regions. This transport and depositional pattern has prevailed since the early Pliocene (ROSS and UCHUPI, 1977; COLEMAN *et al.*, 1981). The submarine cone of the Nile, closing the Cyprus Basin southwards, is supplied mainly with terrigenous sediment coming from the Damietta branch, the eastern tributary of the Nile. These sediments are distributed on a large area, due to strong surface currents moving counterclockwise.

A study has been carried out on late Quaternary sediments found in cores drilled in the Cyprus Basin (oceanographic cruise NOE-1984 and two oceanographic cruises organized by the Institute of Geology and Paleontology of Trieste in 1986 and 1987; fig. 1). The predominance of pelagic muds with sporadic layers with a higher sand content, probably deriving from a distal turbidite, and the foraminifers and ostracods association show that sedimentation occurs in a pelagic environment.

The sequences observed clearly reflect physical-oceanographic conditions which led to repeated anoxic phases in the Levantine Basin during the Plio-Quaternary. Evidence of this is the cyclic repetition of the facies studied, with colours gradually fading from beige to light gray and dark gray (sapropel/sapropelitic level), then returning to beige in connection with improved oxygenation of the environment.

A number of sapropel levels were dated in the Beta Analytic Laboratory in Washington, while one layer of volcanic glass was assessed to be a Y-2 layer (18,000 years of age) (VINCI, unpublished data). These foundings revealed greater sedimentation rate in the stages of Pleistocene regression (between 13.3 and 17.2 cm/1000) than during the stage of Holocene transgression (between 1.3 and 3.9 cm/1000), as reported also by MALDONADO and STANLEY (1978 and 1979). A study of the mineralogic and geochemical features was carried out on sample layers of the cores. The geochemical analyses was based on those elements (Al, Cd, Cr, Fe, Hg, Mn, Ni, Pb, Ti and Zn) corresponding to the main mineralogic components of sediments trasported by the Nile (EMELYANOV and SHIMKUS, 1986). These elements, in a solution by means of two different types of extraction (total extraction with an acid mix and partial extraction with HNO_3 8 N) were analyzed by atomic absorption spectrophotometry; furthermore, to characterize the sediment, its structural features and its content in organic and inorganic C were studied.

Trace elements distribution in the levels under study led to determine that the geochemical basis consists in Al, Cr, Fe and Ti, which are all elements showing the prevailing supply of terrigenous material. Other elements, such as Hg, Mn and Zn, have a behaviour which is difficult to define with the variables adopted. All elements bind with preference with the clay fraction of the sediment (< 2 µm.), with the exception of Cd and Pb, which are mainly present in the sandy fraction.

Fine sedimentation in the Cyprus Basin is marked by the presence of clay minerals, whose bounds with smectite and kaolinite prove that the terrigeneous material comes from the northeastern African continent. With their distribution throughout the Basin, they determine diffusion of some trace elements (Al, Fe and Ti), while other elements depend more on the non lithogenic fraction of the sediment and therefore on the conditions of the environment where they deposit, as reported also by MURAT and GOT (1987).

In conclusion, therefore, in an environment where recent sedimentation is determined periodically by particular situations with prolongued anoxic phases, the terrigenous sediments coming from the Nile mouth is the determining supply for the Cyprus Basin; these features lasted during the whole late Quaternary.

We wish to tank Prof. H. Got and Dr. M. Fontugne for providing cores from R.V. ""Marion Dufresne" NOE-1984 cruise.

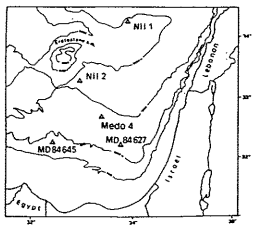

Fig. 1 - cores location in the Cyprus Basin.

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Rôle du Bloc Corso-Sarde dans la formation de la Méditerranée Occidentale

Pierre F. BUROLLET

La séparation du Bloc Corso-Sarde de la marge européenne pyrénéo-provençale est bien connue et de nombreux travaux ont commenté sa migration et l'apparition simultanée de croûte océanique dans le bassin algéro-provençal.

Les travaux récents de la Géotraverse européenne EGT ont apporté des éléments qui permettent d'apprécier le rôle du bloc après sa rotation.

En effet, celle-ci s'est arrêtée à cause du blocage du Sud du bloc contre la marge septentrionale de la Tunisie. On passe de la Tunisie à la Sardaigne par une zone de croûte continentale, amincie certes, mais continue. A mi-chemin entre l'île de La Galite et la Sardaigne, le socle rapide s'approche du fond de la mer, au détriment des terrains plus lents connus le long de la partie tunisienne du profil. On peut interpréter ces terrains rapides comme un lambeau dérivant hercynien ressemblant à d'autres éléments exogènes connus dans la région comme les Massifs Kabyles, le N.E. de la Sicile ou le Massif Calabrais. Ce lambeau aurait été écrasé contre la marge tunisienne par le bloc corso-sarde entré en collision.

Le blocage a empêché la Sardaigne et la Corse de poursuivre leur rotation à la suite de celle de l'Italie péninsulaire; comme celle-ci a continué son déplacement anti-horaire l'espace tyrrhénien s'est agrandi au-delà des possibilités d'étirement de ses marges, d'où l'apparition récente de taches océaniques.

A partir du Miocène supérieur et jusqu'à maintenant le bloc corso-sarde est devenu un poinçon actif dans la compression que l'Afrique fait subir à l'Europe : au Sud les diverses unités ont été écrasées et repliées avec une concentration plus forte des zones tectoniques en Tunisie qu'en Algérie ou en Sicile. En Tunisie, la suture majeure de l'Axe Nord-Sud est actuellement le site de petits séismes, la Tunisie orientale ayant plus de facilité à se déplacer vers le Nord, que la Tunisie occidentale ainsi bloquée vers le Nord.

Au Nord, le poinçon Corso-Sarde a tamponné l'Arc ligure et entraîné un transfert des forces dans ce secteur avec vergence vers l'Ouest et même le Sud-Ouest à l'Arc de Nice. Par ailleurs, dans la zone ligure et au Sud de la Plaine du Pô, on a identifié la superposition de plusieurs unités crustales, Moho compris, se surmontant successivement : unité européenne s'enfonçant sous les Alpes, unité apulienne formant la voûte du Milanais, unité des Apennins ligures et unité Corso-Sarde.

G

Bottom boundary layer measurements off the Po River, Italy

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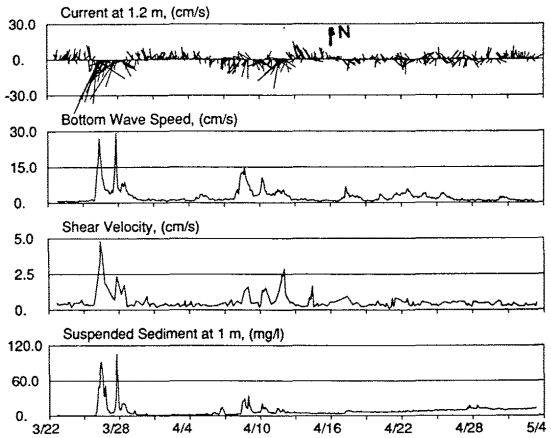
During the 41 day period from 22 March 1990, to 2 May 1990, an instrumented bottom triopod (GEOPROBE) was deployed about 8.5 km SE of the southern flanks of the Po River in about 22.5 m mean water depth. This experiment was part of a cooperative project between the Istituto di Geologia Marina (Italy) and the U.S. Geological Survey (USA) to investigate bottom and near-bottom sediment and pollutant transport on the inner continental shelf along this region. Primary GEOPROBE data included time-series measurements of horizontal current velocity at three levels above the bed, near-bottom pressure and temperature, light transmission at three levels and optical backscattering at four levels. Bottom photographs were taken with a 35 mm underwater camera-strobe assembly every four hours. The GEOPROBE was lowered from a ship within a three point array of closely spaced surface buoys and positioned with the aid of divers. The divers provided in-situ measurements of the tripod orientation, which was selected to provide minimal interference on the current sensors based on the expected average flow direction. The divers also confirmed that the tripod sinkage into the surficial sediment was less than 1 cm at each footpad, and that the tilt was nil. Other instrumentation located near the GEOPROBE included two sediment traps and a profiling C-T-D.

During the GEOPROBE deployment the weather conditions were generally fair, with light and variable coastal winds. However, two storms from the NE and E of moderate intensity transitted the northern Adriatic region on 23-25 March and on 11-12 April, respectively. As will be described, these storms caused significant increases in near-bottom flows and sediment resuspension. Otherwise, the general near-bed conditions were rather quiescent, with weak currents and wave energy, and low amounts of near-bottom suspended sediment. GEOPROBE pressure records indicate that the tide at this location is of the mixed type, with a maximum range of about 1.0 m.

Fig. 1 shows a detailed plot of selected parameters to illustrate these results. The upper panel (current) depicts the current vectors for the sensor at 120 cm above the bottom. The current data were measured once per second in bursts 360 seconds long every two hours. Each vector in the current plot (Fig. 1) represents a burst-average. Over most of the period the currents were rather low (5 to 15 cm/s) with no clear preferred direction, although in the early part of the record apart form the storm passage of 22-23 March the currents were mostly to the north. During both storm periods the current speeds increased substantially, reaching maxima of 40 cm/s and 26 cm/s on 26 March and 11 April, respectively, and were directed toward the SSW. Significant increases in wave velocities occurred during the storms, with peak near bottom wave speeds of 25 to 30 cm/s during the earlier event and 10 to 15 cm/s during the latter one (Fig. 1). Otherwise, near bottom wave speeds were low (<10 cm/s).

The increased current and wave speeds during the storms were associated with rather large shear velocities (u^*) near the bed (Fig. 1) and elevated suspended sediment concentrations at 1 m above the bottom as determined from the transmissometer data (Fig. 1). The u^* values in Fig. 1 were derived from the GEOPROBE velocity data using a least squares fit of the "law of the wall" for rough, turbulent boundary layers. Values of u^* are shown only for regression coefficients of the fitted line ≥ 0.995. The u^* values apply to the portion of the bottom boundary layer dominated by the current, but are enhanced by the wave motion (GRANT and MADSEN, 1979).

Calculations using the GEOPROBE data applied to the Glenn and Grant (1987) model of combined current and wave flows show that the model and data-derived estimates of u^* and roughness length compare extremely well. Bed shear velocities computed from this model have large values during the storms (u^* = 3 to 3.5 cm/s), well in excess of that needed for sediment resuspension at this site. The moderate storms therefore produced significant sediment resuspension and sediment transport toward the SSW during the GEOPROBE measurement period.



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A high-resolution MCS study of the Western Alboran Sea evolution (SW Mediterranean Sea)

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More than 800 k of high-resolution multichannel seismic profiles were gathered in the western Alboran Sea onboard B/O *HESPERIDES* during the first 1991'testing cruise. The profiles were oriented to cut the major structures observed during previous seismic cruises (MALDONADO *et al.*, 1992). Two different morphostructural domains identified in the deep sectors, bounded by the continental margins of Spain and Morocco, include basins and structural highs (CAMPILLO *et al.*, 1992). The three deep basins characterized are limited by structural blocks of the acoustic basement. The western Alboran Basin is the largest showing the thickest depositional sequences, while Malaga Basin and south Alboran Basin are less developed and they have thinned depositional sequences. The faults limiting the basins trend roughly NW-SE and NE-SW and they show a normal to strike-slip component, with the exception of the faults that bound the Alboran Ridge and south Alboran basin which show an inverse to strike-slip component from Pliocene to recent times (BOURGOIS *et al.* 1992; CAMPOS *et al.*, 1992). The structural highs are largely attributed to metamorphic rocks of the Alboran Domain, although local intrusions of volcanic rocks may be important, such in the Alboran Ridge and Djibouti Bank.

The western Alboran Basin was initiated in the early Miocene by normal faults which have subsided the basin until present time. The seismic profiles show one of the most impressive sequence of Neogene deposits reported in the western Mediterranean Sea, with more than 4 seconds (twtt) of terrigenous sediments. These deposits are disrupted in the axis of the basins by deep-seated diapirs of undercompacted muds. Seven sequences from Tortonian to Quaternary deposits bounded by unconformities are identified in the basins, which can be correlated with major tectonic and paleoceanographic events. Two unconformities correspond to large erosive events, which developed major channels (fini-Messinian and intra-Pliocene channels), trending westward from the Strait of Gibraltar and deeply entrenched in the underlying deposits (CAMPILLO and others, 1992).

Malaga Basin starts the opening to the SW and it was affected by important subsidence during the Tortonian within a transtensional regime, probably in favour of strike-slip faults. During the Pliocene time the most important tectonic activity in the basins has ceased. South Alboran Basin was, in contrast, developed as a synclinal related to the positive flower structure of the Alboran Ridge (BOURGOIS and others, 1992).

The stress regime in the western Alboran Sea seems to be at present transpressional, with the deformation accumulating along the structural highs, the continental margins and Alboran Ridge, while the basins are undergoing active subsidence.

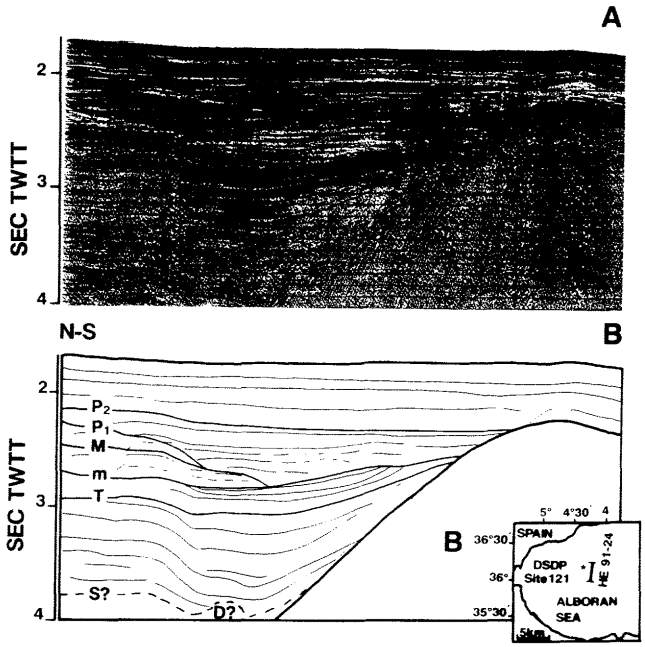

Figure 1.- High resolution MCS profile after Z-Stack (A), and line drawing interpretation of the profile (B). Key horizons: S, top of Serravallian sequence; T, top of Tortonian sequence; m, top of lower Messinian sequence; M, Late Messinian unconformity; P_1, top of lower Pliocene sequence; P_2, top of upper Pliocene sequence; B, basement; D, diapir.

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Quaternary carbonate sedimentation in the Western Sardinian shelf

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The presence on the sea bottom of reliefs of tabular form was detected at depths varying fromp about -40 to -130 meters along the continental shelf of western Sardinia by means of S.B.P. (3.5 KHz) and Sparker (0.5 ÷ 1 KJ) recordings. These morphological structures are especially extensive in the sector facing the Sinis Peninsula (Mesa de Maluentu) as well as in the sector facing Alghero in the north and the Sulcis Archipelago in the south.

The Mesa de Maluentu (LECCA, 1982; LECCA *et al.*, 1983), following the study grabbed, cored and dredged samples, was found to be a strictly carbonate bioconstructed and bioclastic shelf area (CARBONI *et al.*, 1989). The structure of Maluentu, at depths from about -40 to about -75 meters, is characterized by the presence of grooves and extends towards the greater depths (75 ÷ 135 meters) over steps and spurs, usually terminating in sharp drops. Moreover minor structures are found to a depth of about -120 ÷ -135 meters. A non-systematic sampling of the summits and slopes of these structures produced not recent Lithophyllum bindstones and recent coralline crusts; in the grooves, recent, almost exclusively bioclastic-algal sediments were found.

The non-recent *Lithophyllum* bindstones present polyphase micritic fillings with Brachiopods and Foraminifers and have a framework porosity. This lithotype constitutes a buildup, now partially eroded, that developed over an undetermined period of time in the Quaternary, without excluding a Pliocene age.

Recent products overlying the limestones mentioned above are also prevalently made up of encrusting red Algae (*Lithophyllum, Lithothamnium* and other crustose Coralline Algae. ADEY & MACINTYRE, 1973) both *in situ* and in the detritus. The presence of *Halimeda tuna* was also observed, but this does not contribute in this context to the coarse bioclastic fractions, perhaps because of the low degree of calcification.

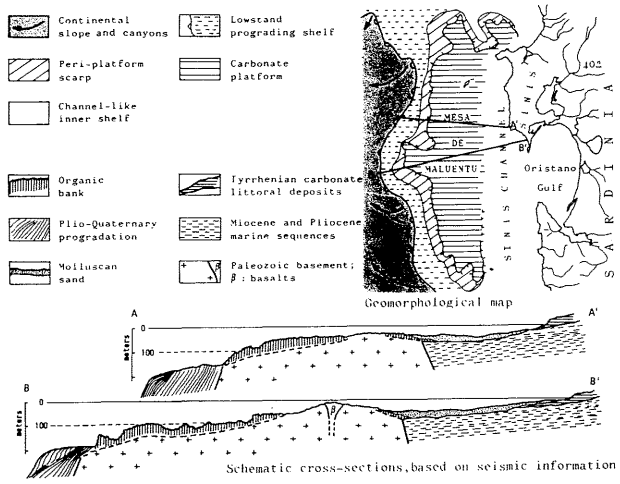
Landwards, the Mesa de Maluentu delimits a canal-like depression down to about -50 meters, where the algal bioclastic feeds with Mollusks now accumulate together with lesser amounts of inland terrigenous contributions.

The shelf-slope transition on the seaward side of the Mesa is formed by a narrow complex oblique-parallel-sigmoid progradation which grew lately during the Quaternary regressive phases, with contribution from the Mesa as well as from the innermost parts of the shelf, and to a lesser degree during the transgressive phases with a draping of carbonate mud and bioclastic contribution from the Mesa seaward scarps.

The dredging, southwards of the Mesa, to a depth of about -120 ÷ -140 meters of Vermetidae limestones and quartzose bioclastic beach sandstones referring to the last Wurmian lowstand bears witness to the importance of the boundstone and bioclastic carbonate facies even during the Quaternary regression phases.

On the other hand, the outcropping along the present-day coastline of various bioclastic carbonate facies bearing Mollusks and red Algae, which can be referred to the Tyrrhenian sea level, demonstrates the high carbonate organogenic production that took place in the phases of greatest Quaternary transgression.

The whole of the depositional systems with a high carbonate component found in this shelf segment, in the Western Mediterranean Sea, is an example of a medium latitude carbonate platform that functioned at the variable glacio-eustatic sea levels of the Quaternary, with also variable carbonate facies productivity. The carbonate character of this shelf is enhanced by a tectonic high, made-up of Paleozoic basement and Tertiary overburden and basalts, situated longitudinally on the present-day medium shelf on which the carbonate framework of the Mesa de Maluentu formed. Another favorable factor is given by the poor contribution of terrigenous sediments along the Sinis coasts ; these sediments are deviated into adjacent areas by the special tectonic configuration of western part of central Sardinia.



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Sedimentological characters of the area North of Eratosthenes seamount (Cyprus sector of the Eastern Mediterranean Sea)

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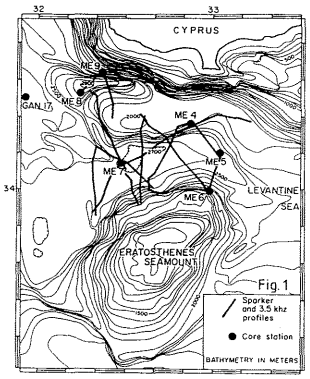
Three small basins occur in the sector North of Eratosthenes Seamount and South of Cyprus Island in the Eastern Mediterranean Sea (Fig. 1). The largest one is the Eratosthenes basin which is characterized by compressive and extensional tectonics on its northern and southern flanks respectively (FINETTI and MORELLI, 1973; CATANI *et al.*, 1983; ANASTASAKIS and KELLING, 1991). From a seismo-stratigraphic point of view, high resolution Sparker and 3.5 kHz S.B.P. surveys point out the existence of Messinian evaporitic substratum, dipping northward beneath the south-verging Cyprus Arc thrust system. The overlying Plio-Quaternary sediments transgress on the Messinian substratum with a conctact of onlap type. Their attitude is almost everywhere undisturbed, except for the northern part of the basin where they are involved in the compressional tectonics of the most external and youngest part of Cyprus Arc. As for the provenance of the Plio-Quaternary sediments, both core samples and seismic profiles (sparker and S.B.P.) demonstrate that they mainly slided down from the flanks of the Eratosthenes Seamount, by means of prevailing slump and mass-flow mechanisms, these phenomena being clearly recorded by sedimentological data. The remaining terrigenous materials coming from Cyprus are trapped by a morphological high, acting as a barrier; in the western sector of the examined area the sediments sliding down along the slope are trapped in a narrow small and deep basin (near cores 8 and 9 in Fig. 1). Organic fraction emphasizes the existence of two sedimentary domains in this sector. In fact, reworked material, with high interspecific differentiation, characterizes the northern area; conversely, in the South the number of species is low and with very high intraspecific abundance. Grain size analyses also confirm the existence of these two domains; the surficial sediments are fine and homogeneous in the whole area, while the deeper sediments of each core prove that terrigenous input prevails in the cores near Cyprus, while pelagic sedimentation dominates in the southern cores and in the GAN 17 core (Fig. 2). Due to the low contents of smectite, the mineralogical study of clay fraction demonstrates the limited influence of the nilotic sediments in this area, while the high values found for illite and chlorite would mean that the eolian transports played an important role (Fig. 2). Based on the ash layers analysis on ME 4 core, sedimentation rate is very high (24 cm/1000 yrs) South of Cyprus, from 18,000 up to 8,000 years B.P., while it abruptly diminishes to 5 cm/1000 yrs in the last 8,000 years. Such a difference seems related to the sea-level lowstand that occured during the 20,000-10,000 yrs B.P. interval (STANLEY and MALDONADO, 1979), with a consequent increasing of terrigenous contributes from Cyprus. These data are confirmed by the study of Y-2 and W-3 ash layers recorded in the GAN 17 core. They display a constant low rate of sedimentation (4,1 cm/1000 yrs, from 120,000 to 100,000 yrs B.P.), beeing far from the mainland and characterized only by pelagic sedimentation. This situation seems well confirmed by heavy mineral composition (epidotes, amphiboles, clinopyroxenes and orthopyroxenes). In fact, it can be observed that a gradual decrease of epidotes (typical mineral of Cyprus suite) occurs from the bottom to the top of the cores, which should be a direct consequence of a similar reduction of the clastic input from Cyprus. Moreover, in the eastern cores an increase of amphiboles and clinopyroxenes and a decrease of epidotes confirm the more important provenance of the sediments from Eratosthenes Seamount. In conclusion, the recent sedimentation study of this sector of the Levantine Sea allowed the identification of three areas with a peculiar prevailing sedimentation mechanism of different material supply : the first, along the southern Cyprus continental slope, is influenced by Cyprus terrigenous input, the second, placed North of Eratosthenes Seamount, is mostly characterized by gravity flows, and lastly, a western area, steadily dominated by pelagic sedimentation. In all the examined areas, nilotic contributes are rather reduced, while the eolian transport influences the northern sector.



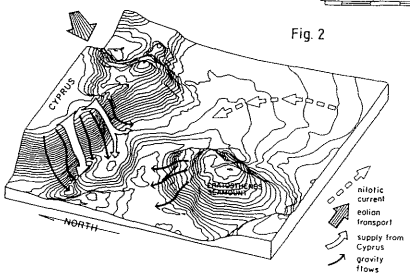


Fig. 2

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The sediments of the Gulf of Antalya (Southern Turkey)

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This paper reports the results of a study carried out on 4 cores collected in the northern part of the Antalya Basin, on the slope-margin of the basin, during the MAC-GAN cruise (Groupe MAC GAN, 1986; ROSSI *et al.*, 1988) and on 7 beach samples gathered near to the main rivers of the Turkish coasts from Kemer to Anamur (Fig. 1). In order to characterize these sediments and to point out their source area and depositional mechanism, grain size and mineralogy analyses of the sediments were performed on all the cores; heavy mineral identification was carried out both on the beach samples and sandy levels within the cores. In the Antalya Gulf a narrow platform develops with a steep continental slope. Many submarine canyons, acting as pathways of turbiditic flows, cut the slope; the main one is going away in front of Antalya Harbour, in a North-South direction. The Antalya basin reaches a maximum depth of 2600 m and is limited in the southern part by seamounts of the Cyprus Arc.

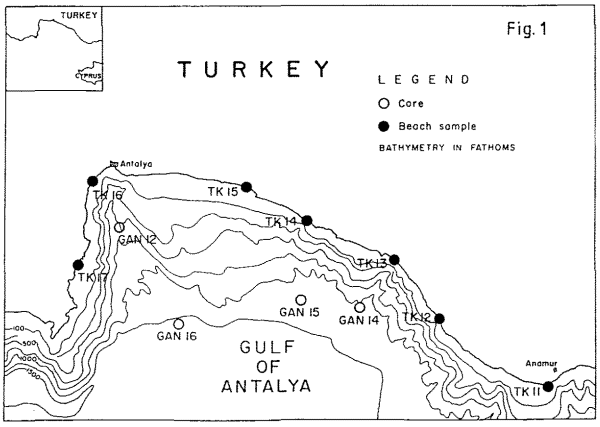
A previous study by CATANI *et al.* (1986) of the central part of the basin showed that it is characterized by two zones with different morphological and sedimentological features: coarser sediments and several turbiditic flows occur in the northern part, mainly in the north-eastern zone near Antalya canyon; conversely, clay rich sediments and several thick sapropelitic levels mark the southern part of the basin.

The stratigraphy of the cores shows a noticeable difference between the sediments located along the axis of the Antalya Canyon and those sampled in the eastern sector of the area : in fact, the former are coarser, with frequent occurrences of sands and even gravels. GAN 14 and GAN 15 cores often show alternated sandy turbiditic layers, with silty-clayey levels. In particular, in the GAN 12 core the top of a debris flow, with rounded elements of 2-6 cm size, supported by scarce coarse sand matrix has been collected. Moreover, these coarse deposits prove that frequent mass flow episodes, identified also by 3,5 kHz survey, took place.

Only one tephra layer was recognized in core GAN 15; the source area was identified after chemical analyses on the vitreous fraction and on the basis of refractive index and mineral content. This ash layer (Y5) has trachytic composition and mineralogical association characterized by augite, aegirine-augite, horneblende, biotite, apatite; this layer is correlated with the ignimbrite campana eruption dated at about 34000 years B.P. The remaining cores are free of pyroclastic material.

The mineral composition of clay fraction, determined by conventional X-ray diffraction methods, shows that there is remarkable little difference in the bulk composition of the sediments of the Antalya Gulf. With respect to the cores collected in the Antalya Basin (CATANI *et al.*, 1986), these sediments are richer in smectite and montmorillonite, as a proof of a marked influence of terrigenous inputs from the mainland. Mineralogical analyses, performed on sands collected from cores and beach samples, point out that the clinopyroxene-amphibole- orthopyroxene association is typical of both the Antalya canyon and the coast West of the town, while the garnet-chloritoid-amphibole association is typical of the Alanya coast and of the facing continental slope. Some minerals, e.g. tourmaline and olivine, mark out a convergence of the coastal transport towards Antalya.

Lastly, on the basis of the only one ash layer found in the GAN 15 core the sedimentation rate results of 9,3 cm/1000 yrs in the last 34.000 yrs; a remarkable decrease of sediment grain size in the core occurred approximatively 13.000 yrs B.P., the finer sediments being probably related to the sea level highstand still persisting.



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Chemical composition and X-Ray mineralogy of beach sands, Corfou Island, Greece

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Sands from 3 beaches of the Corfou island, namely Arila, Glyfada and Ag. Georgios, were analysed for a number of major, trace elements and main minerals. In particular SiO_2, Al_2O_3, Fe_2O_3, MgO, CaO, Na_2O, K_2O, TiO_2, P_2O_5, MnO, Ba, Co, Cr, Cu, Li, Ni, Pb, U, V and Zn were analysed with I.C.P., Corg with LECO carbon analyser, and the main minerals with X-ray diffraction analysis. The highest levels of SiO_2, Al_2O_3, Fe_2O_3, K_2O, TiO_2 Ba, Cr, Ni, V and Zn are in general found in the sands of Arila and Ag. Georgios beaches while the Glyfada beach sands contain relatively high values of CaO and MgO. Cu, Co, Pb, U and Corg appeared to be uniformly distributed. Quartz, and calcite mainly of terrigenous origin, are the main minerals.

Introduction

The beaches of Arila, Glyfada and Ag. Georgios at the western coast of the Corfou island (Fig.1), consist of well to very well sorted sands and in some cases sands and gravels, materials of second cucle or erosion, which are supplied by streams and coastal erosion (CONISPOLIATIS, 1989). The principal rock types supplying coarse sediments to the beaches are Tertiary sandstones, breccias, conglomerates marls and conglomerate limestones (MARAGOUDAKIS, 1967, GEOL.MAP OF GREECE, 1962).

The aim of this research is to evaluate the main minerals present in the beach sands, to the levels of SiO_2, Al_2O_3, Fe_2O_3, MgO, CaO, Na_2O, K_2O, TiO_2, P_2O_5, Corg ,Ba ,Co, Cr, Cu, Li, Ni, Pb, U, V, Zn and to delimit areas of anomalous composition.

Materials and Methods

60 sediment samples were collected from beaches of the western coast of the Corfou island, for sedimentological, mineralogical and geochemical analyses. The results of the sedimentological analyses have been given in a previous investigation (CONISPOLIATIS, 1989).

The samples were examined under the binocular microscope and the bulk mineralogy of the powdered samples was studied by X-ray Phillips diffractometer. The main minerals were determined semi-quantitatively according to the method of NORRISH and TAYLOR (1962). The samples were analysed chemically with Inductively Conpled Plasma (ICP) after a total digestion by a HF-$HClO_4$-HCl mixtute. Corg was analysed with a LECO carbon analyser.

Results

The most abundant minerals are quartz and calcite. Quartz ranges from 13% to 37% and calcite from 17,8% to 46,2%. Major and trace elements levels, fall in the ranges : SiO_2, 25.36-66.12%; CaO, 15.36-33.81%; Al_2O_3, 0.70-2.40%; MgO, 0.58-5.33%; Fe_2O_3, 0.03-1.59%; Na_2O, 0.27-1.62%; K_2O, 0.22-0.66% ; TiO_2, 0.03-0.57%; P_2O_5, 0.12-0.23%; MnO, 0.02-0.11%; Corg, 0.07-1.11%; Ba, 41-514 ppm; Co, 8-27%; Cr, 43-383%; CU, 43-383 ppm; Cu, 2-23%; Li, 11-26 ppm; Ni, 7-59 ppm; Pb, 2-7 ppm; U, 2-5 ppm; V, 15-39 ppm; Zn, 6-24 ppm.

Discussion and Conclussions

The microscopie examination revealed very low contents of biogenic material (shells and shell fragments) (<4%) and heavy minerals (<3%). Therefore, the abundant calcite seems to be of terrigenous origin. The main minerals of various size fractions were also examined : calcite and dolomite tend to be concentrated in the coarser sand fractions, quartz in the medium sands and feldspars tend to be concentrated in the fine and very fine sand fractions.

The concentrations of CaO and MgO in the Corfou beach sands, in general, are high compared with the average values of CaO and MgO in sandstones and shales given by PETTIJOHN (1957) and AHRENS (1965), respectively.

The highest values of SiO_2, Al_2O_3, Fe_2O_3, K_2O, TiO_2, Ba, Cr, Ni, V and Zn are found in the sands of Arila and Ag. Georgios beaches while the sands of the Glyfada beach are characterized by relatively high values of CaO and MgO. Cu, Co, Pb, U and Corg appeared to be uniformly distributed, their levels are generally low and did not indicate any significant input. The mineralogical and chemical composition of the beach sands seems directly correlatable to the rock lithologies of the adjacent land. The extremely low levels of Corg could be due to the sandy nature of the sediments. Two samples from the Glyfada beach, being relatively enriched in Corg and Cu, are considered to have been contaminated to some degree with domestic sewage.

Fig.1. The Corfou island and the beaches mentioned in the text
1: Arila, 2: Glyfada, 3: Ag.Georgios

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Ridge and swale morphology on the North Adriatic epicontinental shelf

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The Adriatic sea is an elongate and narrow (800x200 km) epicontinental basin. The basin is characterized by a wide gently sloping shelf to the north, the Meso-Adriatic Depression below the shelf-break (140m), and a more complex area to the south. Sediment ridges are well known from the north Adriatic shelf trough the studies of BRAMBATI & VENZO 1967; COLANTONI *et al.* 1979, 1991 ; CAVALERI & STEFANON 1980.

During the late Quaternary lowstand of sea level, subaerial erosion and alluvial deposition dominated the north Adriatic shallow shelf and deposition of a coastal lowstand wedge occured on the northern shelf edge of the Mesoadriatic Depression. These coastal and fluvial surfaces were drowned and reworked by marine processes during the most recent (post 18ky) eustatic rise of sea level. Barrier island complexes and delta front bars formed during the transgression and present highstand have a patchy distribution reflecting shift in sediment sources. This study examines a small field of ridges previously examined by COLANTONI *et al.* (1979).

The data base comprises approximatly 480 km of 3.5 kHz high resolution seismic reflection profiles and 250 km of UNIBOOM profiles collected in 180 km2 during 1990 and 1991 cruises by IGM-CNR. Navigation was based on GPS integrated with hyperbolic LORAN C. Absolute positioning errors are less than 50 m.

The rhythmic ridge swale morphology of the shelf area lying 20 km SE of Venice is best identified through a detailed bathymetric map contoured at 1m intervals (fig . 1). The spacing between the ridges varies from 300 to 900m ; their height varies from 1 to 4.5 m. Ridges crests have NW-SE (320°) orientation. The ridges are relatively wide and clearly asymmetric with the steep side facing SW and with slopes of 0.4° to 4.2°. Fifteen samples from two troughs and one crest show the grain size to vary from fine to medium sand. The crest population is moderately well-sorted, while the trough population is poorly sorted.

The main ridge field rests on a sediment mound that parallels the regional bathymetric contour and is bounded landward by an elongated trough. Most of the subbottom reflectors identified in the 3.5 kHz records are sufficiently persistent and nearly horizontal ; others dip gently to the south. The shallowest one lies just beneath the ridges and is exposed in some of the troughs and may be related to the peat horizon found at 80 cm below the surface in a trough.

Possible interpretation for the ridges formation include origin as: erosional remnants of subaerial dunes or depositional bodies formed in a submarine setting. The latter interpretation appears more supportable from our data. Based on a ratio of subaerial dune high to width of 1;15, the ridges, as they exist today, would have to have been 24m high as subaerial dune. For them to be reformed to their present shape would have required extensive erosion. The lack of evidence of such erosion, including an absence of eroded sand and a consistent crest height, argue against such an origin.

More likely, the ridges formed by submarine processes. The ridges are strikingly similar in length, shape, and crest height and have consistent orientation and consistent asymmetry to the southwest. The depth-average velocity required to produce sand waves of this type is about 40 to 80 cm/sec (from RUBIN & McCALLOCH, 1980) and such a peak could be reached during exceptional storms or by high tides combined storm surge (MOSETTI, 1985) in the north Adriatic sea. Unfortunately little data on currents are available in the study area. The sediment composing the ridges was probably derived from a relict body (delta lobe, littoral bar) as it was reworked in the first stage of the transgression. The marine origin of the sediment is also attested to by the presence of shell fragments and marine foraminifera.

The next step to a better knowledge of the origin of these bottom features is a regional detailed bathymetric map followed by long cores sampling and bottom current measurements, in order to understand the relationship with other bottom features and the erosional processes related to the subbottom main surfaces.

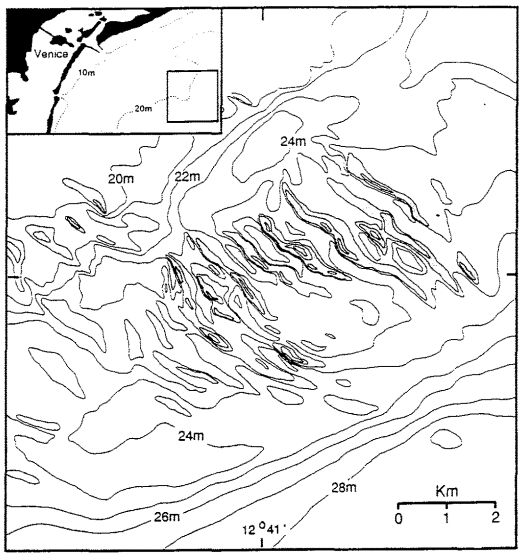

Fig. 1 - Bathymetric map contoured at 1m intervals. The dotted area points out the ridge morphology.

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Mer Rouge et mer d'Alboran : Etude morpho-structurale comparée

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L'analyse morpho-structurale du segment nord de la mer Rouge met en évidence un certain nombre de particularités qui conduisent à admettre que, dans les premiers stades de l'ouverture d'un océan, l'évolution tectonique superficielle ne reflète pas directement le processus profond responsable de l'amincissement de la croûte continentale.

Ceci n'apparaît pas à première vue. Si l'on examine, du N au S, l'aspect général de la mer Rouge en partant de sa terminaison septentrionale en arc, jusqu'au paralèlle 17° N, on constate une remarquable correspondance entre les deux rives de la Mer. Aux creux de la rive Est répondent les bosses de la rive Ouest et inversement, ceci presque perpendiculairement à l'allongement général de la Mer. Au S du 17° N, la comparaison, rive à rive, ne peut être poursuivie que si l'on fait abstraction du "triangle des Afar", région déprimée comprise entre - la côte, - le méridien des Iles Dahlac, de ces îles à l'entrée du Rift -Est-africain, et - une ligne qui de ce point, court au pied du Harar, jusqu'au port de Bulhar. Sous cette condition, à l'angle saillant de la côte yéménite correspond l'angle rentrant "éthiopien" du triangle.

C'est cette disposition de l'ensemble Mer Rouge-Golfe d'Aden qui a conduit à la position extrême de certains auteurs pour qui la mer Rouge, le triangle des Afar et le golfe d'Aden sont un domaine essentiellement océanique. Pour reconstituer l'état antérieur, il conviendrait dans ce cas, de rapprocher, côte contre côte, l'Afrique et l'Arabie.

Compte tenu de ces apparences, on pourrait s'attendre à ce que la structure de détail du segment de mer, situé au N du 17° N, présente la même régularité que la disposition d'ensemble. Ce n'est pas le cas, comme cela a été montré dans des publications antérieures (v. notamment COUTELLE, PAUTOT, GUENNOC, 1991). Dans ce segment, par exemple, la vallée "axiale" ne suit pas l'axe de la mer. C'est ainsi que dans sa partie la plus profonde, au niveau de la fosse Mabahiss, elle est beaucoup plus proche de la côte arabe que de la côte africaine. A partir de ce point, d'ailleurs, elle se dirige en oblique vers le Golfe de Suez qui en est le prolongement naturel au sein du continent africain.

Remarquons qu'ainsi, "l'orthodoxie dynamique" du dispositif d'ensemble est fortement altérée. La vallée axiale, en effet, aurait dû s'arrêter ou se prolonger dans le Golfe d'Akaba puisque celui-ci est le lieu de passage de la Faille du Levant, qui joue, ici, le rôle d'une faille transformante. Dans le même ordre d'idées, on notera que la direction -N12- de cette faille, devrait logiquement, être aussi celle du mouvement de refermement bord à bord de la mer. En fait, cet assemblage se fait selon des directions orientées au N47.

Il apparaît donc bien que, le creusement du bassin marin, la cinématique de l'écartement Afrique-Arabie et la structuration de détail sont des processus assez largement indépendants.

Dans un contexte tectonique différent, puisque généralement compressif, la mer d'Alboran montre une morphologie semblable. Bien qu'il n'y ait pas ici l'équivalent d'une vallée axiale, le moindre remplisssage sédimentaire autorise une lecture linéamentaire du fond marin qui aboutit à une conclusion identique : les structures développées sont le reflet de l'héritage continental, au sein duquel il est même possible de séparer l'héritage ibérique de l'héritage maghrebin. Le détroit de Gibraltar correspond aux Golfes de Suez et d'Akaba, puisqu'il est à la fois le lieu de passage d'un accident majeur (la Faille Açores-Gibraltar) et qu'il est dans le prolongement de la dépression centrale de la Mer, sans, d'ailleurs, être dans son axe. La découpe des côtes et des reliefs qui les longent, du méridien 2°E jusqu'à Gibraltar - à part l'encoche volcanique de Melilla - montre, là encore, une remarquable correspondance transversale des saillants et des rentrants des rives opposées ainsi qu'une évidente terminaison en arc de cercle ("l'Arc de Gibraltar").

L'indépendance relative entre le processus créateur d'espace marin et la structure locale est ici, spectaculairement illustré par la grande discordance des limites de la mer par rapport à celles de la chaîne alpine.

L'étude morpho-structurale comparée de la mer Rouge et de la mer d'Aboran, montre que dans des contextes dynamiques différents, l'action des processus d'océanisation réalise des morphologies très semblables. Tout se passe comme si l'on avait affaire à une océanisation s'exerçant à partir d'un point glissant sur une trajectoire légérement sinueuse et dont l'action s'étendrait dans un rayon de l'ordre de la centaine de kilomètres. L'arrêt (provisoire ? définitif ?) de cette transformation se marque par la terminaison arrondie des deux mers. Le comportement du socle continental soumis à amincissement, apparaît relativement passif. Il semble n'induire que des retouches de détail dans une morphgénèse dont le déterminisme semble venir des profondeurs.

On peut envisager que l'amincissement crustal est réel et qu'il correspond à une érosion sous-crustale du continent ou qu'il est partiellement apparent et qu'il résulte d'une imprégnation mantellique ascendante. Quelqu'en soit la manière, l'assimilation peut être complète et aboutir à la formation d'un fond océanique qui, dans ce cas, ne résulterait pas, exclusivement, de l'écartement de deux plaques et du fonctionnement d'une zone d'accrétion.

L'examen des cartes géologiques des pays riverains de la Méditerranée, montre divers exemples de mers pouvant résulter de l'action de tels processus d'océanisation *in-situ*, tels le Golfe de Valence, le Golfe du Lion, le Golfe Ligure, la mer Tyrrhénienne, la mer noire, voire la mer Caspienne.

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G

Sedimentology, texture and composition of the mud diapirs and mud volcanoes of the Mediterranean ridge

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From 1978 to 1990 twentyt-wo of the sixty piston and gravity cores raised from the four mud diapiric fields identified on the crestal area of the western and central Mediterranean Ridge (Figure 1, CITA *et al.*, 1989; CAMERLENGHI *et al.*, in press) have recovered a sticky dark grey matrix-supported brecciated material containing sedimentay clasts of millimetric to centimetric size. The term mud breccia has been used since 1981 as a descriptive term to identify the lithology of this material (CITA *et al.*, 1981).

The mud breccia has been characterized in its mineralogical composition (carbonate content and clay mineral identification), paleontological content (foraminifera and cooccoliths), texture, sedimentology, geochemistry (gas content, carbon and oxygen isotopic composition), and physical properties.

The main characteristics are:

Lithology: There are no major differences among the different investigated fields. A dark grey (hue 7.5 to 2.5 YR, Munsell Soil Colour Chart) mud breccia with a typical yellowish oxidation layer at the contact with the host hemipelaic oozes is found. The matrix is composed of clay and silt. Most of the clasts have a marly composition, range in color from gray to light brown, and are slightly indurated. The total carbonate content measured on the matrix varies from 12 to 34% in the central Mediterranean Ridge fields, and is only a few percents in the westernmost field. Gas is present (methane and higher hydrocarbons).

Texture: We have distinguished three types of mud breccia. A coarse, firm type where clasts are contimeter-size, and no foliation can be observed; a fine type with millimetric clasts often organized in rough bedding; a muddy-homogeneous type, with very fine grain size composition, homogeneous texture, and millimetric gas vescicles.

Sedimentology: Sedimentary structures can be clearly identified only in the fine type of mud breccia. Planar bedding, rough sorting and finig-up gradation can be recognized. A quantitative analysis of the millimetric indurated clasts retained by the 63µ sieve shows that shape is mostly spherical and elongated.

Composition: the material retained by the 63µ sieve shows quartz, carbonatic fragments, siltstones, shales, glauconite, and pyrite. The clay mineral composition shows higher abundance of smectite in the eastern diapiric fields, where the clay mineral assemblage resembles that of the present Nile derived sediments. An indurated quartz-arenite clast suggests an origin related to the Peleozoic sandstones of the Syrte Basin or to the Oligocene-Miocene Numidic Flysch facies of Northern Africa.

Stratigraphy: The Mud breccia is not found in a precise stratigraphic position. It has been found interfingered in hemipelagic sediments from Late Pleistocene to Holocene. The age distribution of the foraminiferal and nannofossil taxa indicates highest abundance in the Late Oligocene and Lower Miocene for the eastern fields. The Western field shows Aptian (middle Cretaceous) foraminiferal tests.

Physical properties: Consolidation tests performed on oriented specimen indicate that the mud breccia behaves as a remolded material. Very little or no anysotropy has been found in the consolidation curve and the porosity resulted slightly lower than in the surrounding hemipelagic sediments (about 50%). SEM observation of undisturbed specimen did not reveal orientation of the sediment microfabric.

These compositional, textural, and sedimentological observations allow to conclude that :

1) The mud-breccia has been intruded in recent sediments in low shear strength condition as an underconsolidated material. Part of it has been extruded on the sediment surface as a mud volcano that has originated mud flows.

2) In the three eastern fields, the mud breccia has been originated from Late Oligocene-Early Miocene clay rich formations belonging to the African geological domain. We tentatively identify the fine grained facies of transitional environment deposits like the Marada Formation of the Sirte Basin (SELLEY, 1969), widely distributed on the northern african margin, as a possible source material. In the westernmost field the extruded material is older (Aptian) and no source formation has been so far identified.

Finally, we point out the striking textural similarity between the Mediterranean Ridge mud breccia and some of the sedimentary melanges of the Apenninic chain.

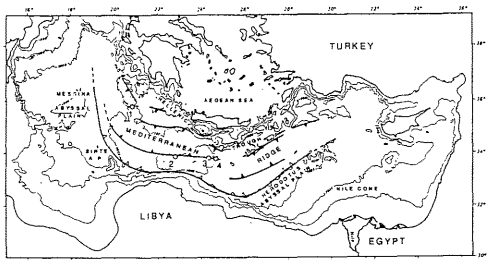

Figure 1. Location of the four diapiric fields: 1- Cobblestone Area-3; 2 - Pan di Zucchero Area; 3 - Prometheus-2 Area; 4 - Olimpi Area.

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Influence de la Tectonique sur la morphologie sous-marine au sud de Marseille (Méditerranée occidentale)

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Lors de la campagne MESEA I (BELLAICHE *et al.*, 1991) réalisée par le *N/O J. CHARCOT* en 1990, les relevés SEABEAM ont été localement accompagnés de profils sismiques (canon à eau). Ces derniers mettent en évidence l'influences des déformations tectoniques du socle acoustique sur la morphologie actuelle des canyons de Marseille, Planier et l'Estaque (fig. 1).

La région explorée peut schématiquement se diviser en deux grands domaines. A l'Est du méridien de Marseille, le substratum acoustique correspond à un socle de nature endogène métamorphique et le recouvrement sédimentaire plio-quaternaire est très aminci. A l'Ouest de ce méridien, le réflecteur acoustique s'ennoie très rapidement et on ne peut en préciser la nature lithologique. Corrélativement l'épaisseur des dépôts sédimentaires augmente et correspond au développement d'une importante série mio-plio-quaternaire. Une telle dualité semble normale, la série la plus épaisse se situant dans le prolongement du couloir rhôdanien.

Les cartes bathymétriques SEABEAM révèlent que les entailles des canyons et des principaux thalwegs annexes présentent deux directions privilégiées : NW-SE et NE-SW (BELLAICHE *et al.*, 1991). L'existence de ces deux directions est liée à des accidents du socle acoustique.

Les entailles NE-SW sont caractérisées généralement par des fonds aplatis que l'on peut relier à des effondrements localisés du substratum plutôt qu'à des incisions linéaires ou des glissements.

Les entailles NW-SE montrent plutôt un profil en V, et leur tracé présente une ressemblance avec un réseau fluviatile de type "infantile". Les profils sismiques permettent d'observer la coïncidence des axes des fonds de thalwegs avec des accidents cassants qui affectent le socle acoustique.

Les enregistrements montrent que le creusement des thalwegs semble bien être la conséquence de deux mécanismes successifs :

- une érosion linéaire et/ou des glissements longitudinaux qui accroissent les pentes latérales des entailles;
- des glissements latéraux des sédiments mio-pliocènes accumulés sur les flancs ou les interfluves.

Le rôle de ces glissements dans l'acquisition du modelé se traduit par deux types morphologiques principaux:

- des ressauts de la pente, curvilignes et emboîtés (COUTELLIER, 1985) qui remodèlent les interfluves et peuvent évoluer en véritables vallées sous-marines par érosion régressive ;
- des escarpements parallèles aux axes des thalwegs, qui sont à l'origine de l'allure rectiligne de nombreux interfluves.

Les profils sismiques ont permis d'établir une carte isochrone du socle acoustique. Ce document montre que le tracé des thalwegs paraît sollicité par une ébauche de réseau de dépressions imprimé dans le réflecteur acoustique. En outre, ces dépressions sont bien souvent liées à des accidents tectoniques visibles sur de nombreux profils.

Ainsi dans le secteur de notre étude l'origine des glissements pourrait résulter de plusieurs causes. Comme COUTELLIER (1985) nous pensons que les phénomènes gravitaires interviennent pour une large part dans le déclenchement des glissements. On peut aussi penser que ces glissements sont la conséquence de faibles rejeux successifs, au cours du Plio-Quaternaire, des accidents observables dans le socle acoustique. Les deux phénomènes seraient complémentaires.

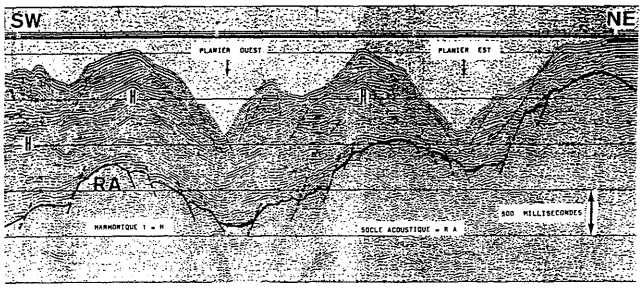

Fig. 1. Superposition des axes de canyon avec les fractures du socle acoustique.

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Geophysical study of the Southern Adriatic basin

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By the interpretation of a great amount of multichannel seismic reflection data and of the heat flow density data it is possible to infer that the Adria plate began to detach from the African Megaplate in the Middle-Upper Triassic. Complete separation occurred in Middle Jurassic and stretching phase continued also in Cretaceous and later on. The Dogger tectonic activity determined a crustal thinning and persistent deep sea condition in the Southern Adriatic basin and induced halokinetic movements in the Upper Triassic salt layer (Burano Formation).

The compressive meso and neo-alpine tectonic processes of Dinaric orogenesis created a diffused thrusting deformation accompanied by some evident strike-slip movements.

Since the Southern Adriatic basin is the foredeep of the Dinarides and the Apulian platform is its foreland, the Apenninic orogenesis affected only in a light manner this depression area. But during the Neogene-Quaternary alpine activity, progression of the thrusting deformation of the Dinaric system, and foundering of the adriatic foredeep took place, very probably accompanied by new crustal stretching and thinning with local mantle uplifting.

Quaternary features in Palma Bay (Baleares, Spain) and surrounding littoral areas : A physiographic approach

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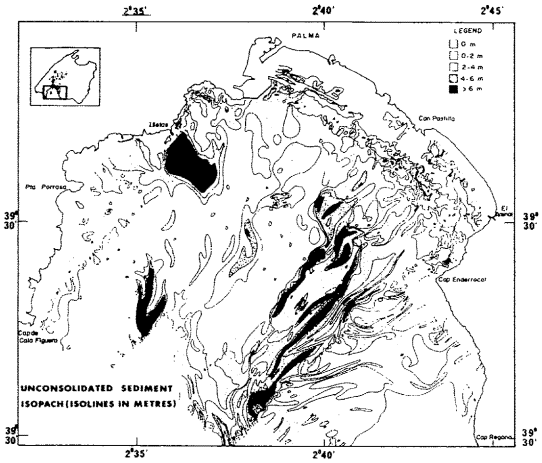
Palma Bay is a shallow semienclosed enbayment located in the Southern of the Mallorca island in the Western Mediterranean. Its morphology is slightly flat, deepen gently in a SW direction. The uppermost litoseismic unit, Quaternary in age, has two different depositional bodies infering two different genesis as well, on the basis of the recent geological evolution developed in the area. From the analysis of the data available (Uniboom 200 joules, 3.5 kHz, echosounder, side scan sonar, aerial reconnaissance and bottom sediment samples) it seems that a drainage system strongly hierarchized (MATEU *et al.*, 1985) took place over the broad littoral plain formed in relation to the post-glacial relative sea-level drop affecting the Western Mediterranean 18.000 years B.P. (PIRAZZOLLI, 1987). Correlatively to this event an erosional period has been affecting the Plio-Pleistocene basement composing the plain by means of a fluvial encassenment highly active. This is the reason why is possible to identify in the litoseismic record, a lower sedimentary body (channel infilling) in the base of the uppermost unit before mentioned (DIAZ-DEL-RIO and SOMOZA, 1991).

Following this relative sea-level drop, there was a steepy-state sea-level rise events, producing a marine carbonate sedimentation (due to high biological productivity) fozilizing the drainage system in successive stages. This evolution finally reach the present time being possible to recognize a smooth sea bottom in the bay, widely covered by a sandy sheet occupied by a seagrass meadow that contribute to sedimentation with great amounts of carbonate skeletons from the living organisms coexisting in this particular ecosystem.

In this poster we present the results of the study in a form of "Physiograhical Map" showing the main units (depositional and morphological) recognized in the area, and also a chronology of the littoral units (Early Pleistocene to Holocene). This approach let us stablish the interrelation between seabottom units and littoral ones during the Quaternary, and also to infer the role of the benthic communities in the present sedimentary process.



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G

Erosion and Transport of Suspended Sediment Near the Po River Delta, Northern Adriatic Sea.

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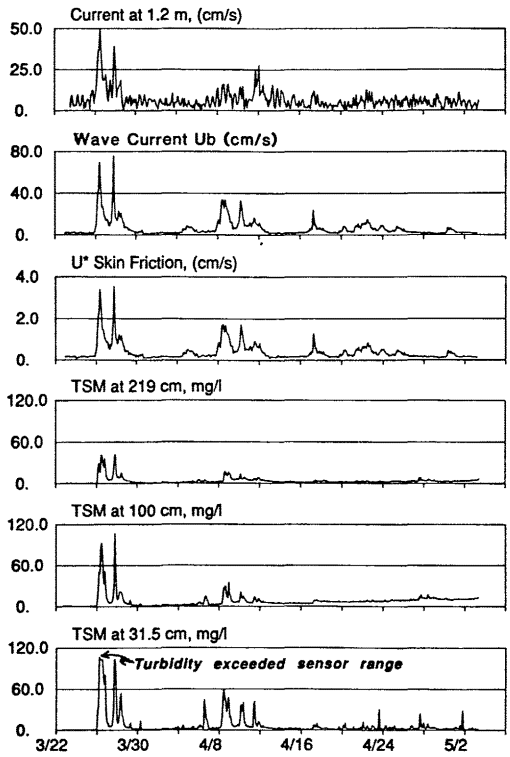
During the 41-day period from 22 March 1990 to 2 May 1990, an instrumented bottom tripod (GEOPROBE) and two sediment traps, at 2 m and 10 m above the seafloor, were deployed about 8.5 km off the Po River delta in 22.5 m water depth. This experiment was part of a cooperative project between the Istituto di Geologia Marina (Italy) and the U. S. Geological Survey (USA) to investigate the erosion and transport of sediment and pollutants on the inner continental shelf in this region. The GEOPROBE data, discussed in detail separately by CACCHIONE *et al.*, included time-series measurements of horizontal current velocity at three levels above the bed, near-bottom pressure and temperature, light transmission at three levels and optical backscatter at four levels. Bottom photographs were taken every 4 hours with a 35 mm camera-strobe system. Bottom sediment samples collected by divers are principally composed of terrigenous silt and clay with less then 10% sand; mean diameters are 5-8 µm.

Although winds were light and variable for most of the deployment, two storms of moderate intensity transited the northern Adriatic on 23-25 March and 11-12 April. Currents and waves, which were weak during the non-storm periods, increased significantly during the storms and generated combined bed shear stresses as large as 12 dynes/cm^2 at the GEOPROBE site (see figure 1). The oscillatory currents produced by the surface waves made the major contribution to the elevated bed shear stress. The bed stresses during the storms were well above the erosion threshold (about 1 dyne/cm^2) for the local sediment, as shown by the rapid increases in suspended sediment detected by the optical sensors.

Suspended sediment concentrations at 7 levels within the bottom 2.2 m of the water column were estimated from the GEOPROBE optical data using laboratory calibration curves developed specifically for the local bottom sediment. The results show that suspended particulate matter (SPM) concentrations during low energy conditions were of the order of 1-5 mgl^{-1} and the material was relatively uniformly distributed in the bottom boundary layer. In contrast, during the March storm, SPM concentrations increased to a maximum of >175 mgl^{-1} at 0.3 m above the bottom and there was a strong vertical decrease in SPM concentration with height above the bed (figure 1).

The observed vertical SPM decrease in a strongly turbulent flow (U*c > 3 cm/s) suggests that the average settling velocity of the eroded sediment grains was equivalent to fine quartz sand (d = 0.01 cm). Since the local bed contains <10% sand, it is likely that the sediment was eroded as large clumps and aggregates during the storms. This hypothesis is also indicated by the rapid decrease in SPM concentrations after the storm waves began to diminish.

The combined-flow bottom boundary layer model of Glenn and Grant (1987) was used to predict flow characteristics and SPM concentrations during the storm periods. Using the *disaggregated* grain size distribution of the local bed sediment as input, the model-derived estimates of the SPM concentration at z = 0.3 m were within 50% of the measured concentration. However, the model predicted nearly uniform concentrations owing to the small mean grain size. Accurate predictions of sediment transport in regions of fine-grained and cohesive beds will require knowledge of the sizes and densities of the particles in suspension.



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The Rhone Fan (Gulf of lions) and the Var ridge (ligurian margin) : Mediterranean turbiditic systems with contrasting architectures and growth patterns

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The comparison of the architecture of the Rhone Fan and Var Ridge, located in contrasting physiographic and tectonic settings of the northern mediterranean margin, emphasizes some of the main factors controlling the deep turbiditic sedimentation.

Despite strong differences in size and in physiographic and tectonic settings, the structure of both turbiditic systems is comparable and is defined by the stacking up of depositional units represented on seismic sections by two main types of acoustic bodies (DROZ and BELLAICHE, 1985; BELLAICHE *et al.*, 1986) which are also recognized in other fans (DAMUTH *et al.*, 1988) :

-the turbiditic lenticular units: they are grouped within larger acoustic bodies, the channel/levee complexes. Within these complexes, the geometry of the stacking of the units evolves downstream and is specific of the different environments of the fans. This type of acoustic bodies is the most frequent and can represent up to 80-90 % of the sediments of the fans

-the chaotic bodies representing mass-movement deposits are much less frequent and seem to be grouped at specific stratigraphic levels of the fan.

The main differences opposing these two fans concern their growth pattern:

-Seismic analyses indicate that sedimentation in the **Rhone Fan** results from (Fig.1):

*periodic **lateral displacements of the depocenters**, which are responsible for the individualisation of the channel/levee complexes. They are most commonly tectonically- or morphologically-induced and can be or not linked to preferential periods of instability.

***longitudinal displacements of depositional area** which are probably mainly eustatically-controled. Quaternary sedimentation in the Rhone Fan is marked by a general but discontinuous progradation of the turbiditic front, probably reflecting the effects of the quaternary glaciations.

-In contrast, the structure of the **Var Ridge** (highly asymmetrical upper part of a larger turbiditic system, the Var Fan) is apparently more simple: deposition did not significantly suffer **neither lateral** (except for a progressive and local northwards migration of the upper Var Valley) **nor longitudinal displacement**. This structure results from the combination of tectonic and physiographic influence which induced the stability of the depositional area and the overgrowth of the ridge.

The contrasting characteristics of the two fans are presumably related to the difference of intensity with which sea-level variations control deep turbiditic sedimentation. An important parameter that influence the intensity of this factor is the physiographical characteristics of the margin:

-in the first example, the **Rhone Fan**, sedimentation is **primarily controlled by sea-level fluctuations**. The contrasting physiography of the Gulf of Lion (wide shelf and well-expressed shelf break) is highly favourable to a good record of the effects of this factor.

-in the second example, the **Var Ridge**, deposition is **mainly under tectonic and physiographic influence**. Sea-level changes are of much lower influence because of specific morphological characteristics of the ligurian margin: the absence of continental shelf prevents any accumulation on the upper parts of the margin during high sea-levels, and leads to the permanent feeding of the basin.

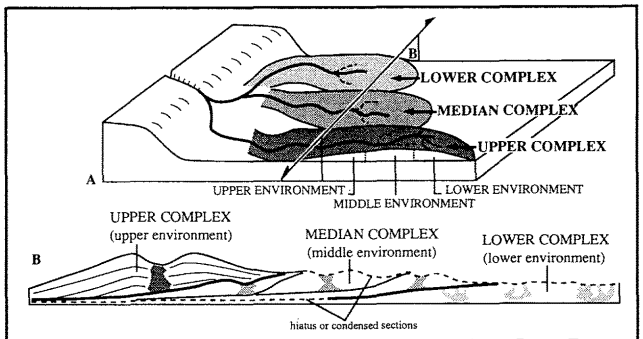

Figure 1 : Lateral and longitudinal shifts of depocenters in the Rhone Fan (slightly modified from Droz, 1991)

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Texture, Chemistry and mineralogy of Lake Manzalah sediments, Egypt

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Lake Manzalah is the largest of the four Delta lakes, with a surface area of about 60 % of their total area (1350 km2). The lake was connected to the River Nile (Fig. 1) by the fresh water Enaneya and Ratama canals. It has south western connections to the sea and sewage water flows into its south east basin (El Bakar canal) as well as into the south and south west basins (Ramsis and Hadous drains).

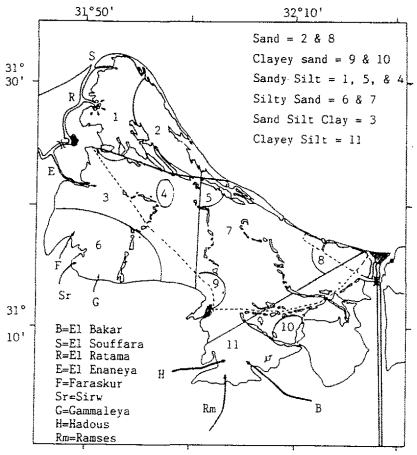

Figure (1): Area of Study

Sixty nine sediment samples were collected from the bottom surface of lake Manzalah and were subjected to mechanical, chemical and mineralogical analysis. Most samples are poorly to very poorly sorted. The predominant type of sediments is the silty sand type (zones 7 and 6) followed in abundance by the complex type sand-silt-clay (zone 3) and clayey silt (zone 11) respectively (Fig. 1). The sand fraction spreading along the northern and north eastern sides is mainly derived from the Mediterranean beach sand penetrating through the lake-sea connection (ElSouffara canal and El Gamil opening) as well as wind blown sand. Such distribution of sediment type reflects the hydrographical changes and the total absence of Nile sediment load - which previously used to enter the lake - after the construction of Aswan High Dam.

By comparing the present results with those of Port Fouad (EL SABROUTI *et al.*, 1989) and Bardawil (LEVY, 1974) lagoons we found that the difference in hydrographic conditions affected greatly the type and distribution of the sediments in all three areas. The coarse fractions occurred in the lagoons peripheries where as the central zones are covered with finer sediments. No drains flow into these two lagoons. The Mediterranean sea and Sinai are the main sediment source for Port Fouad lagoon, while the Mediterranean Sea is the only sediment source for the Bardawil lagoon.

The mineralogical analysis showed that the heavy minerals of the lake samples are similar to those of the Nile sediments. Amphiboles, opaques, pyroxenes and epidotes are the common heavy minerals derived from the Abyssinian plateau of the central African complex. Less frequent are garnet, rutile, zircon, tourmaline, kyanite and biotite. Aragonite is the dominant carbonate mineral with subordinarly high Mg-calcite and calcite. The areas covered by fine sediments have low carbonate content because fine sediments inhibit the flourishing of benthic fauna and because of the inorganic materials discharged into the lake by drains.

The average organic matter content is 5.2 % lower than that found by ABOUL DAHAB *et al.*(1990) for lake Mariut (average 14.1%). The organic matter, organic nitrogen and total phosphorus contents (averages = 5.2 %, 0.28 % and 0.02 % respectively) are higher in the peripheral zones eg. at El Bakar, Ramsis, Hadous and El Gamaleya drains, which may be attributed to the sewage drainage. The distribution of the organic matter, organic nitrogen and total phosphorous follows more or less the same pattern of sediment distribution in the lake, being highly found in the zones of silt and clay and lower in sandy areas.

The average $CaCO_3$ content is 14.25 %, while $MgC0_3$ content is 3.4 %. The relationship between Ca and Mg carbonates is not consistent, because Mg carbonate concentration depends on the type and nature of the calcareous organisms dominating in the sediments.

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Preservation of reactive organic phosphorus in shelf sediments west of the Nile Delta, off Alexandria

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Phosphorus is one of the nutrients limiting growth in natural waters. Contrary to the open ocean, phosphorus cycling in estuaries and coastal sea areas is influenced by river input in both dissolved and particulate form, contributions of sewage and the intensive contact of water masses with the underlaying sediments. Thus, phosphorus in shallow sea areas is subject to both biological and physicochemical controls (BALZER, 1986). Phosphorus in the sediment may be found in pore water adsorbed to particles, bound to calcium, chemisorbed by ironoxyhydroxides, and contained in organics (KROM and BERNER, 1981; BLAZER, 1986). MEYBECK (1982) estimated that phosphate content of river waters already has been increased globally by a factor of three ; the additional load, however, is distributed unevenly over the world and may reach a multiple of this factor in highly polluted areas.

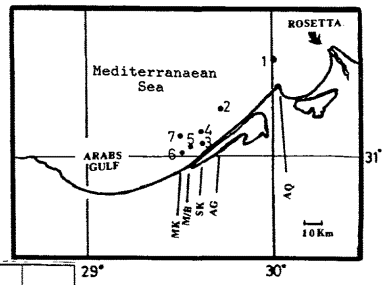
The present study aims to study the levels of organic, inorganic and total phosphorus in the shelf sediments of Alexandria region. Subsequently, the amount of buried phosphorus will be quantified.

The area of study locates west of the Nile delta. This area received, but little amount of the Nile load. Salinity varies from 37.77 ‰ to 38.83 ‰. Dissolved oxygen ranges from 5.28 ml/l to 6.00 ml/l in surface water, decreases with water depth and ranges 4.95 ml/l to 5.56 ml/l near the bottom. This area is not comprehensively studied, as most of the studies were carried out off the Nile delta. The investigated area covers the innershelf off and west of Alexandria region. It extends from Abu Qir in the east to Marakia in the west. Depth ranges between 10 m and 30 m (Figure 1). Seven sediments samples were collected either by a peterson grab sampler or by Scuba diving. For the determination of total and inorganic phosphorus, the method described by ASPILA *et al* . (1976) was used. The organic phosphorus was obtained by substraction.

Results and Discussion

Results obtained for total phosphorus (TP), inorganic phosphorus (IP), and organic phosphorus (OP) are displayed in figure 2. The organic phosphorus makes up about 20.9% ± 3.72% of the total phosphorus, varies between 15.7% and 27.1%. It has a mean concentration of 6.9 ± 3.37 µmole/g. It is clear that TP varies from station to another, however the relative percentage of IP to OP are almost constant. The maximum concentrations of OP and IP are found to be in Abu Qir station and Sidi Kirer deep station. EL-SABROUTI *et al.* (1990) mentioned that Abu Qir innershelf area is rich in OP. This station are covered with fine sediments, brought from the Rosetta branch (prior to 1965), by the westerly current. Accordingly lower porosity should be obtained for this fine materials, hence prevent the penetration of oxic water from the water-sediment interface. Thus the increasing percentage of OP on TP might be a combined effect of higher accumulation rate in this area and lower degradation efficiency in more anoxic sediments. In Agami station, the low values of TP, IP and OP may account for the type of sediments in this area, which is mainly carbonate sand (83% of the sediments in this area are carbonate, DOWIDAR *et al.*, 1990). According to EMELYANOV and SHINKUS (1986), the average content of phosphorus in the Mediterranean Sea is 0.05% in carbonate materials, compare to 0.5% in organic detritus and 0.1% in siliceous materials. The variation of OP/TP ratio may account for 1. A respective amount of IP is released from the degradation of organic matter which lead to increased of IP, and hence, low OP/TO ratio. 2. Upward migration of IP from anoxic sediment column to the top oxidized sediments layers. This upward flux may contribute significantly to the enrichment of phosphorus in the top layers, 3. Increasing the annual input to the sediment due to man's influence. Phosphorus is intricately involved with main productivity, so it is reasonable to suppose that phosphorus removal might occur by burial of OP in association with organic matter in sediments. We can estimate the burial rate of OP in sediments from the P/C ratio and the pre-agriculture burial rate of organic carbon (OC). The pre-agriculture burial rate of OC was estimated to be 0.99 x 10^{-6} mole-C cm^{-2} y^{-1} (FROELICH *et al.*, 1982). Taking the average P/C ratio obtained during the present study as 1.591 x 10^{-2} and the value of OC burial, we can calculate an OP burial rate of about 1.58 x 10^{-9} mole-P cm^{-2} y^{-1}. This value is considerably low compare the hemipelagic sediments (4 x 10^{-9}) mole-P cm^{-2} y^{-1}, FROELICH *et al.*, 1982). This may be interpreted as reflecting fractional regeneration of OP from OC during oxidation of organic matter during deposition as well as in marine sediments. OP/OC ratio obtained during the present study are almost less than that of Redfield ratio (9.4 x 10^{-3}), sometimes it is only 30% of Redfield ratio. From this it is concluded that part of the reactive OP fraction of the plankton has been preferentially lost (relative to carbon) before burial, both in the water column and in the top few mm of the sediments.

Fig. 1 Area of study and location of samples.
1 = Abu Qir 23 m (AQ),
2 = Agami 30 m (AG),
3 and 4 = Sidi Kirer 10 and 20 m (SK1, SK2),
5 = Marakai/Burg el Arab 10 m (M/B),
6 and 7 = Marakai 10 and 20 m (MK1, MK2).



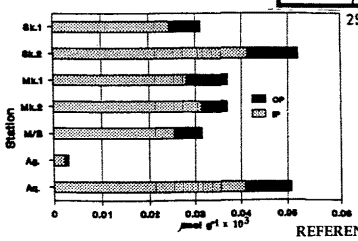


Fig. 2. - Concentrations of Inorganic Phosphorus and Organic Phosphorus in stations sampled.

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G

Cortical Fabrics in the Coated Grains of the Shelf Sediments between Sidi Abdel Rahman and Matruh, Egypt

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The term "Coated grains" was coined by WOLF (1960) as a substitute for FOLK's (1959), to include other concentrically formed materials such as pisolites and Rhodoids (c.f. PERYT, 1983). According to TUCKER and WRIGHT (1990) coated grains are polygenetic in origin with different process forming similar types of grains and many of these process are still very poorly understood.

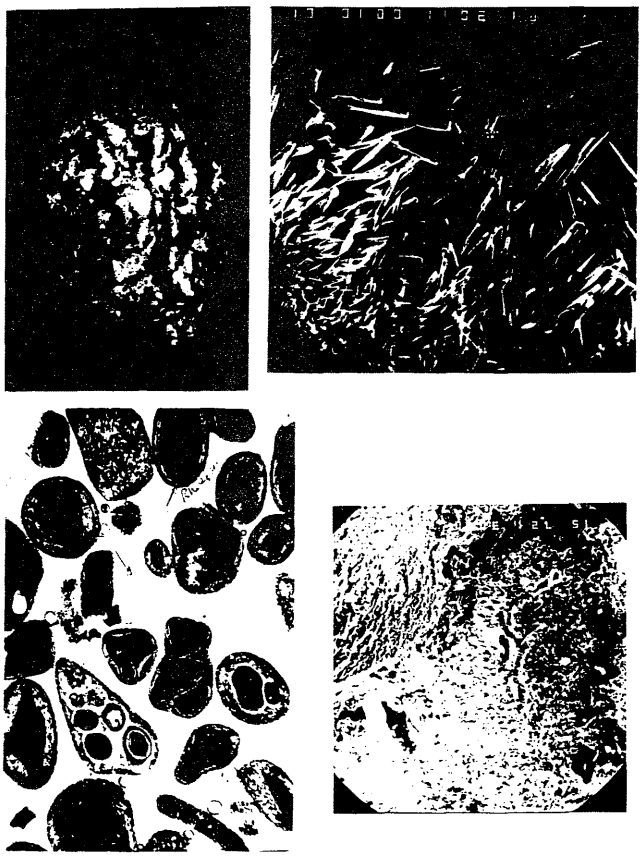
The present study aims to study the types of coated grain, the microfabrics and the mineralogy as well as to study the origin of this coated grains using a combination of SEM, XRD and petrographic techniques.

The study area, situated between Sidi Abdel Rahman and Matruh, covering the beach and the inner shelf, west of Alexandria, Egypt. Shelf sediments were collected using a petterson grab sampler, where beach sediments were collected by hand. Samples were subsequently analyzed for mineralogy (XRD), microfabrics (SEM), petrography (thin sections). For mineralogy the samples were scanned from 25° to 33° (Cu-K*a*) at 1/2 degree per minute. The peak area method (MILLIMAN and BORNHOLD, 1973) was used for calculating the percentage of different mineral species. Thin sections were prepared and studied petrographical. Representative coated grains were analyzed by means of JEOL JSM U-3 Scanning Electron Microscope.

Results and Discussion

Among the coated grain, Both chemical precipitate coated grains (Ooids) and biologically encrusted grains (Rhodoids) were recognized. Most of the ooids collected from the shelf and beach sediments have tangential microfabrics, and consist of aragonite "grains" whose long axes are aligned parallel to the ooid laminae. The grains consist of aragonite rods without crustal terminations less than 3 µm long and have an average diameters of 0.2 µm. Many of the ooids have a complex nucleus. Some of the nucleus are terrigenous grain (quartz) other are carbonate grain (pellets or skeletal fragments).

Rhodoids were also observed, where coralgae has been coated with tangential layers of aragonite. These rhodoids are similar to those rhodoid from Ras Muhammad, Gulf of Aqaba, Red Sea (c.f. HOTTINGER, 1983). Mineralogical analysis reveals that these ooids consist mainly from Aragonite (comprises 80% of the total minerals) and Mg-calcite (12 mol% $MgCO_3$, comprises 20% of the total minerals). On the basis of microfabrics of the studying coated grains, available data on the growth rate of rhodoid (c.f. HOTTINGER 1983), as well as the mineralogical composition of these coated grains. It can be concluded that many of these coated grains are recently formed. However the radial microfabrics of some grains were also found, indicating the presence of ancient ooids. This conclusion agrees with the pervious study on the oolitic sand from the same area of study (ANWAR *et al.*, 1984 ; EL-SABROUTI, 1990).



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Heavy metals in the surficial Aegean sediments along the Turkish coasts

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A suite of 46 surface sediment samples from the eastern Aegean Sea, along the turkish coasts has been subjected to petrographic and chemical analyses, together with land geology, in order to study the main controls on heavy metal dispersal and provenance.

The sediments are mixtures of the varying proportions of terrigenous and biogenous components of variable grain-size composition, whereby the petrology of the terrigenic constituents corresponds closely with the land geology (ERGIN *et al.*, 1990). The mud or muddy sediments commonly dominate near the mouths of the main rivers and the protected areas of relatively low energy conditions. The carbonate contents of the sediments (1-70% $CaCO_3$) normally reflect the amounts of the biogenic material of shell/skeletal remains present, although contributions also occur from terrigenous carbonates, especially off the southern coasts of study area. Biogenic carbonates are mostly confined to areas around islands and peninsulas where the benthonic productivity is seemingly high. In general, the organic carbon contents of sediments are found to be relatively high (0.6-1.9%) at most of the inshore stations located near or at the major river mouths indicating significant contributions from the land-based sources. Otherwise, the majority of the C_{org}-levels in the sediments (0.3-0.7%) can be accounted for the normal marine production of organic matter in the Aegean Sea.

The heavy metal data (Fe : 0.59-5.74% ; Mn : 103-2625 ppm ; Co : 2-41 ppm ; Cr : 9-312 ppm ; Cu : 3-77 ppm ; Ni : 11-406 ppm ; Zn : 19-162 ppm) show a considerable measure of similarity in composition to the average sediments/sedimentary rocks worldwide (TUREKIAN and WEDEPOHL, 1961 ; EMELYANOV, 1972 ; HIRST, 1974 ; SMITH and CRONAN, 1975 ; SHAW and BUSH, 1978 ; VOUTSINOU-TALIADOURI and SATSMADJIS, 1982 ; BODUR and ERGIN, 1988 ; EVANS *et al.*, 1988; ERGIN *et al.*, 1991; YUCESOY and ERGIN, 1991. Exceptions to regional trends reflect : unusual geology in the source areas ; postdepositional mobility of the metal within sediment ; and maybe to some extent, anthropogenic effects. The latter appears to be significant off the Meriç river mouth and inner Izmir Bay, where the concentrations of Cu and Zn are somewhat higher than the average abundance. The levels of Fe off the mouths of Menderes and Gediz rivers are rather high, presumably resulted from the metamorphic rocks of Menderes Massif and related ore deposits. Exceptionally high Mn, and to lesser degree, Co concentrations in the sediments around the Marmaris peninsula maybe due to a combination of substantially input from the terrigenous sources together with diagenetic enrichment in sediment. The distribution of the Cr and Ni concentrations is largely controlled by a contribution from ultramafic rocks and related economic chromite deposits on land. From the relationships among the geochemical variables, it is concluded that the great portions of the metals studied are associated with the Fe, Mn, clay, and to lesser extent, organic fractions of the sediments.

Overall, the distribution of the heavy metals in the surface sediments of eastern Aegean Sea can largely be explained in terms of variations in depositional environment and provenance.

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Reconstruction of Late Quaternary Shorelines in the Eastern Mersin Bay : Inferred from high-resolution seismic records and known sea-level curves

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Analyses of an extensive grid of Late Pleistocene/Holocene erosional surfaces from seismic reflection profiles along with previously published sea-level curves and several sedimentary environment information from Eastern Mediterranean (See ERGIN *et al.*, 1991 and references therein) permit an outline of the paleogeography of the Eastern Mersin Bay (E. Mediterranean) during the Late Pleistocene and Holocene changes of sea level (Figs. 1 and 2.). Taking a reduced accuracy into consideration; when combined with suitable global average sea-level curves not seriously affected by tectonic or isostatic complications, the high-resolution shallow-seismic profiles enable us to construct not only the positions but also the ages of the formerly subaerial and lowered Late Quaternary shores in the Mersin Bay. A number of uncertainties in the rates of sea-level fluctuations, which are difficult to quantify, still remain. Nevertheless, we believe that, with the results presented here, it is possible to interpret the Late Pleistocene to present paleogeography of the continental shelf of Eastern Mersin Bay.

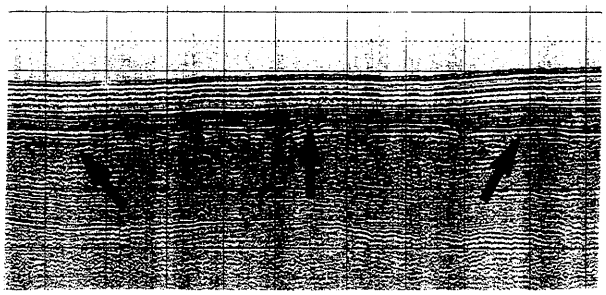

Fig. 1.- High-resolution seismic profile obtained off the coast of Mersin, southeastern Turkey. Note the pre-Holocene erosional surface.

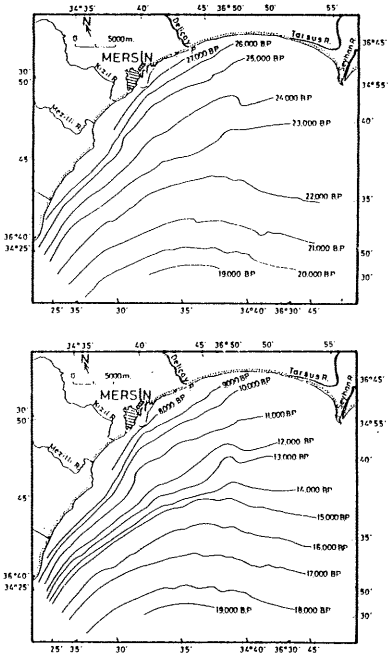

Fig. 2.- Isopach map of the Late Pleistocene (top) and Holocene (bottom) shorelines of Mersin Bay, lasted from about 27 000 to 8 000 yrs B.P.

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Messinian sedimentary history in the Valencia Trough continental margins, Northwestern Mediterranean Sea

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Sparker and multichannel seismic reflection profiles across the Valencia Trough enables a detailed analysis of the Messinian erosional surface and associated deposits. The isobath map of the Messinian surface shows large subaerial canyons draining mainly the Iberian continental margins. Most of these canyons meet the Messinian Valencia Valley, that runs parallel to the axis of the Valencia Trough. In the canyon tributary system we find evidence for several episodes of erosion and deposition during the Messinian.

The depositional processes in the Valencia Trough margins during the Messinian resulted in the formation of three main sedimentary units related to the Messinian drainage system: (1) canyon or valley floor deposits, (2) canyon or valley fill deposits, and (3) alluvial fan or piedmont deposits. At the same time, in the deeper parts of the basin, sedimentation of the Messinian evaporite sequence, took place.

(1) The morphology of many of the Messinian canyons shows trapezoidal crosssectional profiles, and sinuosities between 1:0 and 1:1, which suggest that these canyons transported mainly bedload deposits. In addition our seismic profiles show at the base of these canyons subparallel, high amplitude reflectors. We interpret these to be related to coarse-grained fluvial channel floor deposits, because they occur in incised erosional valleys, in contrast to lenticular depositional turbidite channel-levee complexes that have formed in the Valencia Trough floor in the Pliocene-Pleistocene marine sequences (NELSON and MALDONADO, 1988; ALONSO *et al.*, 1990). Our interpretations are further confirmed by the fluvial and lacustrine deposits reported from DSDP sites 122 and 123 respectively (RYAN *et al.*, 1973; CITA *et al.*, 1987), and drill holes in the Castellon continental shelf that show sands and conglomerates in Messinian thalweg positions (STAMPFLI and HOCKER, 1989).

(2) Canyon-fill sequences are observed in numerous Messinian canyons. They usually show parallel to subparallel high amplitude reflectors onlaping the canyon walls. Locally we observe two cycles of canyon-fill sequences. In this case each cycle starts with subparallel, high amplitude reflectors, related to coarse-grained sediment, and ends with subparallel reflectors of low amplitude, that correspond to fine-grained sediment. The two cycles in each canyon-fill sequence appear to represent transition from subaereal to deep-water marine depositional conditions.

(3) Alluvial-fan deposits are recognized at the mouth of the Ebro and Foix canyons. The morphological character between these two tributaries and the Valencia Valley floor is that of a piedmont plain which received a large volume of unconsolidated sediment eroded during the Messinian time.

The factors controlling the depositional patterns during the Messinian are a combination of tectonics, climate, and sea level changes. The early Miocene rift structures of the Valencia Trough controlled the location of the Messinian drainage network. Volcanic intrusions further affected Messinian drainage patterns and valley morphology. Arid climate prevailed in the northwestern Mediterranean Sea during Messinian. Typically small streams in arid climates can transport far more coarse grained sediment than big river systems in tropical areas. Under these conditions mainly canyons containing bedload deposits were produced.

The three erosive episodes and two fill sequences observed in the Valencia Trough, resulted from fluctuations in the Mediterranean sea level during the Messinian that were related to global eustatic changes and tectonic closure of the Straits. The basal erosional surface corresponds to the early Messinian isolation of the Mediterranean Sea from the world oceans. This caused sea level lowering, subaerieal exposure and erosion of the continental margins. There is little data on this episode but the magnitude of sea level drop is estimated to be about 2.500 m. Restricted inflow periods at the end of this episode brought the necessary marine water to form the main Messinian salt. At the end of the Messinian there is evidence for another episode of isolation of the Mediterranean Sea that is responsible for the formation of the unconformity between the Messinian and the Pliocene sequences. The magnitude of minimum sea level drop at this time is estimated to be about 2.000-2.200 m. In between these two episodes a third intra-Messinian erosional surface has been observed. The different erosional episodes suggest that there were altrernating epidodes of flooding and retreat of Atlantic waters through the Betic Portal and/or Rif Strait, which agrees with the data from tha Betic Strait shown by MULLER and HSU (1987). The opening of the Strait of Gibraltar during early Pliocene resulted in the final flooding of the Valencia Trough basin.

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G

Transport, deposition and distribution of the sediments and suspended matter on marine coastal area (Ligurian Sea)

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An environmental research was conducted by ENEA on the ligurian coastal area. The most rilevant factor which characterize this area are the presence of the Centa mouth, the turistic harbour of Alassio, the large town of Albenga and the island of Gallinara.

This study examines the processes which are responsible for the transport and deposition of sediments and particulate matter on the marine platform and represents an example of research aimed to the determination of the influence of local natural inputs and anthropogenic activities on the coastal environment.

During the summer were sampled alluvial and marine sediments as well as suspended matter from surface and bottom waters (Fig.1). Subottom profiles provided morphological descriptions of the submarine area (CORRADI *et al* 1984).

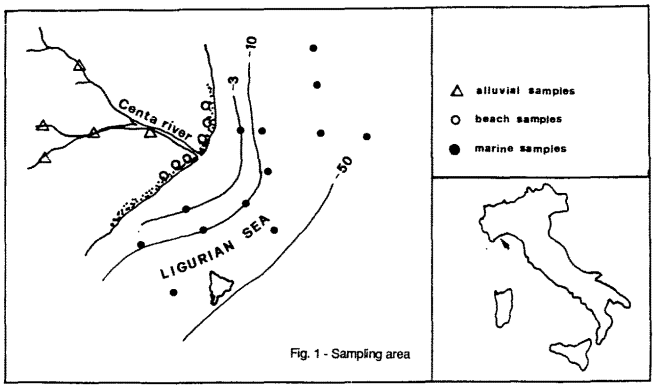

Fig. 1 - Sampling area

All samples were analyzed for granulometric and mineralogical parameters by the Coulter Counter, X-Ray diffraction and Electron Microscopy (COCITO *et al.*, 1985).

Two main alluvial inputs, reflecting the different limestone, flysh and crystalline rocks of the source basins, were identified.

The homogeneous dispersion of sediments in the cone area of the river may, in this case, point to a negligible influence of the longshore current.

Textural and mineralogical characters of suspended matter, however, exhibited an eastward drift (PAPA, 1980).

The heaviest effects of anthropic activity were observed on the beaches near the river mouth, in the areas close to the large urban centres and in the area including the harbour.

The coastline pattern and the peculiar morphology of the shelf are the main factors controlling the settlement of all sedimentary material entering the sea which is of natural as well as of anthropogenic origin.

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G

Contributions to the structural evolution of Perithyrrhenian basins : The example of the Gulf of Naples (Southern Italy)

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The Gulf of Naples is one of the marginal basins, formed on the western Tyrrhenian margin as a consequence of the extensional tectonics, affecting this area after the end of the building up of the Apenninic chain.

Compression began in Southern Apennines in Lower Miocene in the inner zones of the chain; with time compression shifts toward outer zones, where it is active till Plio-Pleistocene. The main shortening of the chain can be dated to Langhian-Tortonian (MALINVERNO and RYAN, 1985).

The Tyrrhenian basin began to extend after the end of the rotation of the Sardo-Corso block (19 Ma; MONTIGNY *et al.*, 1981), that is in the Middle and Upper Miocene. Extension produced the formation of little oceanic basins in the Southern Tyrrhenian Sea, such as Marsili and Vavilov basins (KASTENS, MASCLE *et al.*, 1990).

From this overview it is clear that extension in the Tyrrhenian domains results contemporaneous with crustal shortening in the Apenninic chain and with flexure of the foreland.

The Gulf of Naples, located in the inner zones of the Apennines, was interested through time by both types of tectonics; extensional tectonics, which attenton is focused on, is morphologically more evident, being more recent. Morphology and bathymetry of the gulf and neighbouring areas point out the recent formation of relief: in about 30 km relief goes from + 1,131 m (Faito Mount) to - 1,000 m (Dorhn Canyon, S of the city of Naples).

At least two phases of extension can be identified, based on a structural survey on the mainland, supported by bathymetric, single channel and multi channel seismic data.

The first phase is represented by faults striking about N-S. A N-S fault can be inferred from bathymetry on the western side of Capri, producing a scarp of at least 100 m. Many others direct faults, striking mainly N-S (Fig.1), have been identified in the gulf through single channel seismic reflection profiles. Furthermore, along a N-S lineament six volcanic and subvolcanic bodies developed (Fig. 1), ranging in age from Pliocene to Quaternary. This phase shows the same strike of faults and the same axis of extension (about E-W) as that of the opening of Tyrrhenian Sea, in particular the Central Fault (REHAULT *et al.*, 1987).

The second phase is represented by some spectacular submarine scarps (at least 800 m) (Fig. 1), trending about E-W, which can be interpreted as direct faults. Of particular interest are the ones which border the southern side of the Sorrentina Peninsula; in multichannel seismic profiles they show a step structure, dislocating the sedimentary basement. The axis of maximum extension of the second phase strikes N-S. In the Tyrrhenian Sea no structure compatible with a N-S extension have been reported in literature, so this phase seems to be characteristic of marginal Tyrrhenian basins, such as the Gulf of Naples and the Pontine Island, where a recent N-S extensional phase have been described (PANTOSTI e VELONA, 1986).

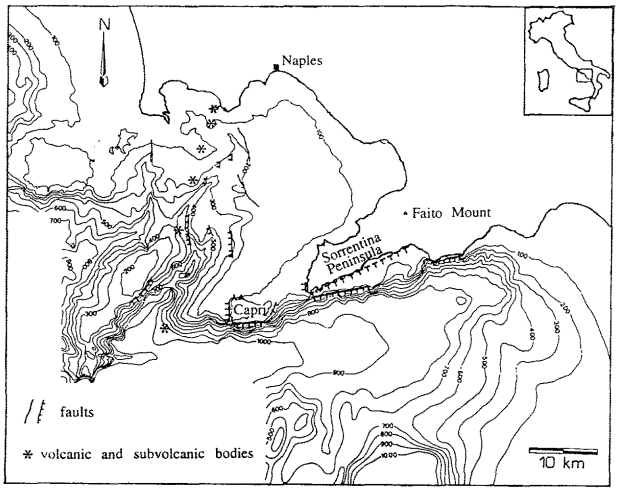

Fig. 1 - Structural sketch-map. Isobaths in m

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Morphology and sedimentary pattern of the Southern Ionian Calabrian margin (South Italy)

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The neotectonic evolution of the Ionian Calabrian margin, external side of the southern Apennines mountain range (Calabro-Peloritanian Arc), is marked by important fault systems transverse or parallel to the chain. They were active, with extensional mechanism, during the Late Quaternary and delimit a regional horst-graben style, respectively characterized by high uplift and subsidence rates (ERGENZINGER, 1978; GHISETTI, 1979). Marine geological and geophysical surveys (high resolution seismic reflection profiles and cores) in the area between *Le Castella* and *Cape Spartivento*, pointed out that the morphology of the shelf-slope system of the margin and its Late Pleistocene-Holocene depositional evolution are mainly controlled by active tectonics, extension of the onland one, along with a remarkable fluvial input and glacioeustatic sea level fluctuations.

Morphological features

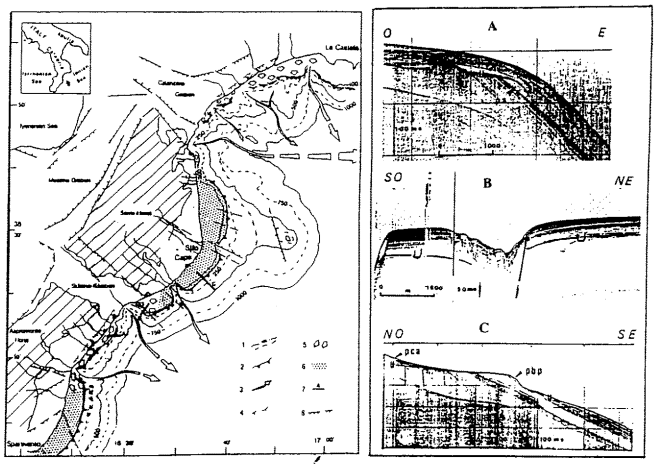
On the whole, the area shows a narrow shelf and a steep slope, deeply cut by several active canyons, which are aligned with the fluvial mouths. The shelf is only 0.4 km wide, irregular and discontinuous due to the canyon erosion in correspondence of the *Catanzaro* and *Siderno* grabens. Around *Le Castella, Cape Stilo* and *Cape Spartivento* it is almost continuous with average width around 6.5 km. The shelf break is, on average, at 115-120 m over the whole area. The slope deepens continuously and without significant breaks (average dip around 4°-6°) in the whole southern sector of the margin. In front of *Cape Stilo* its continuity is broken by wide structural high, which constitutes the seaward side of a small intraslope basin. In the whole northern sector *(Gulf of Squillace)* it is instead composed by ridges, narrow valleys and canyons, tributaries of the main longitudinal Squillace canyon, which mainly trends NNW-SSE.

Gravity deformations of different kind and size (creep, debris, slump) are diffused along the entire slope and the most pervasive of these events are probably triggered by the high seismicity of the area.

Depositional setting

The shallow seismic records (3.5 kHz S.B.P., Uniboom and Sparkarray 1000-3000 J) across the shelf- slope system within the study area show a superposition of seaward progradational units. The youngest of these overlays a prominent shelf-wide erosional unconformity, formed during the last glacio-eustatic sea level fluctuations (about 18 ka B.P.; BORSETTI *et al.* 1989) and truncating former middle late Pleistocene progradational units, still under investigation (GABBIANELLI, *in prep.*). In the zone of graben areas with a narrow shelf, this unit is represented by a upbuilt and outbuilt of accretionary shelf-slope sequence, which reaches thicknesses around 30 ms. A buried sedimentary prism, probably connected to the low stand sea-level phase, is some times detectable within the sequence in correspondence of the shelf break. In these areas the erosive unconformity reaches maximum depths around 170-180 ms and, in particular, it is sharply cut and lowered in correspondence of the fault system *(Roccella Ionica-Marina di Nicotera)* controlling the northern side of the Siderno graben. On the other way around, in areas with wider shelf the youngest depositional sequence is marked by a modern sediment wedge that thins near the shelf edge and reaches landward a maximum thickness of about 25-30 ms. A small sedimentary prism is continuously developed along the whole shelf edge in front of *Cape Stilo* and *Cape Spartivento* while the shelf wide erosive unconformity is at an average depth of about 140 150 ms.

Legend - Morpho-structural sketch map of the Ionian Calabrian margin (data on land from GHISETTI, 1979, modified) and seimic sections across the shelf-upper slope system. 1. isobath in meters ; 2. shelf break ; 3. main canyons ; 4. main breaks ; 5. draped sediments and buried wedge areas ; 6. shelf areas with coastal aggradational wedge and sedimentary shelf break wedge ; 7. location of profiles : U = erosional unconformity, ps = buried sedimentary wedge, pca = modern sedimentary wedge, pbp = small sedimentary prism at the shelf break ; 8. faults.



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Meteo and hydrodynamic conditions governing the recent evolution of the Ebro delta

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Since the end of the forties -when the construction of large dams in the lower Ebro valley began-, the Ebro delta front has behaved as a stretch of poorly-nourished sandy coast under the action of both the local meteorology and marine hydrodynamics (S.-ARCILLA *et al.*, 1990).

The main role of meteo agents is driving or influencing the water motions off the Ebro delta. Apart from that, the wind stress acting on the local sediments produces noticeable eolian transport in some areas such as the Fangar dune field and the Trabucador bar (fig. 1). Strong prevailing "mestral" winds from the NW may produce alongshore drifts of sediments compensating for a small part of the littoral transport at the Fangar area, whereas the (unfavourable) effect of the mestral winds on the Trabucador bar is migration of sand from the backshore to the beachface.

Wind waves (i.e. high-frequency water motions) and associated surf-zone currents appear to be the primary driving mechanism for the sediment transport in the Ebro delta coast. Available directional wave data show that "llevants" -seas and swells from the NE or E directions- are the most energetic sea states and account for most of the wave energy flux reaching the Ebro delta (GARCIA *et al.*, to be published. See fig. 2). This is coherent with the directions of the alongshore littoral transport derived from sediment budget calculations (JIMENEZ *et al.*, 1990).

Tidal motions do not seem to have any remarkable influence on the large-scale evolution of the Ebro delta coast. Data retrieved from local tide gauges yield a tidal range of ca. 20 cm (LOPEZ, to be published). Surges associated to storm events are a much more important factor that astronomical tides. Meteo- induced elevations of the mean sea level (MSL) of 50 cm are not exceptional, as they may happen more than once per year. The effect of these surges is clearly understood when storm events like that of 8th to 11th October, 1990 are considered. As described in JIMENEZ *et al.* (1991), the elevation of the MSL favoured then a break-through of the Trabucador bar under high-but-not-too-high wave height conditions.

Low-frequency motions, ranging from inertial oscillations to quasi-steady currents, are only capable of transporting sediments either near the Ebro mouth -where the amount of suspended sediments is relatively important- or at deeper locations, provided that waves produce resuspension of bottom sediments. Field results from CACCHIONE *et al.* (1990) show that such a process hardly occurs beyond the delta "mud belt", which extends as deep as 20 m. On the other hand, advection of material may not follow the prevailing current direction to the SW but be instead affected by mesoscale phenomena such as spatial variations of the wind stress field and transient water exchanges across the shelf edge (GARCIA, 1990; TINTORE *et al.*, 1990), which can give rise to local gyres of different character.

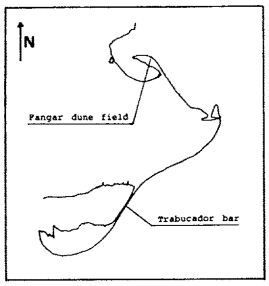

Fig. 1 Location of the Fangar dune field and the Trabucador bar within the Ebro delta.

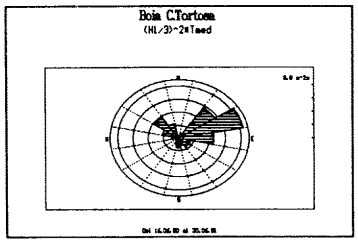

Fig. 2 Distribution of the local mean wave energy flux at deep water.

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WARRS study of Alboran Sea and Strait of Gibraltar

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During a period from 30th. of October, to 5th. of December 1991 the Research Cruise R/V-*Valdivia*(V117) of the Institut für Geophysik Universität Hamburg conducted a seismic (wide-angle reflection and on refraction seismic (WARRS) and high resolution reflection seismic) investigation of Alboran Sea and the Strait of Gibraltar. This Project was a joint venture between : Institut für Geophysik, Universität Hamburg, Instituto Geografico Nacional, SNED, SECEG-SA, and Centre National de la Recherche.

The aim of the project was to :

- solve problems posed by the regional tectonics and geological situation, and
- develop a crustal and upper mantle model for on/offshore Marocco-Mediterranean-Spain. For this purpose 15 OBS (Ocean Bottom Seimographs) and 40 LOBS (mobile seimic land stations were deployed several times on both research areas. We obtained 390 km WARRS lines in the Alboran Sea and 225 km in the Strait of Gibraltar. An airguns array with a total volumen of 371 produce the seismic energy. Shooting was extended beyond the ends of the lines in order to obtain an overlap. Additionnal 20 shots on approximatly the same position (stack shots) were fired at the ends and the centre of each profile (figure 1). A detailed high resolution reflection seismic study in the Strait of Gibraltar completed the survey and covered more than 560 km seismic lines (figure 2). We will present our 1th. results and discuss the tectonic implications.

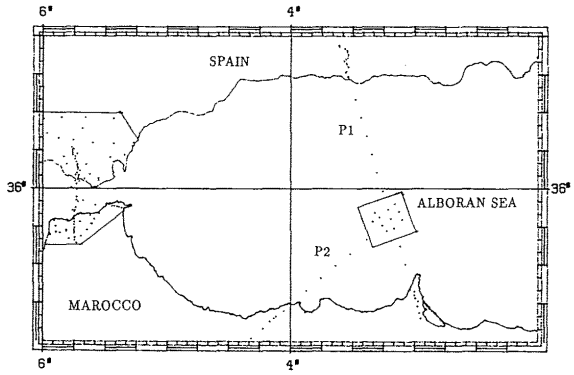

Fig 1: Location map of the on/offshore microseismic areas and the OBS/LOBS positions.

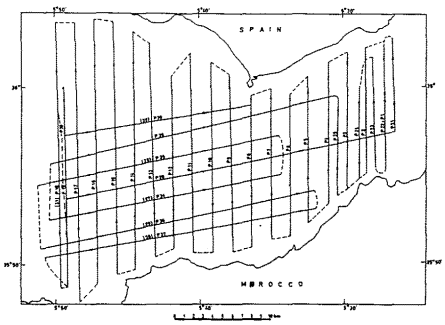

Fig.2: Location of single-channel reflection seismic lines in the Strait.

The morpho - and hydrodynamics of the coastal zone of the Gulf of Kyparissia

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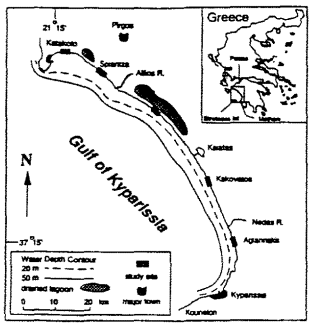
The gulf of Kyparissia is located on the western coast of Peloponnesos (SW Greece), has NE-SW orientation, shoreline length of about 63 km, crescentic shape and is bound by headlands. The aims of the present study are: 1) to determine the sediment transport pattern and estimate the sediment flux in the gulf, 2) to document the relationship between the nearshore wave and current velocity fields and the morphological changes that result in the evolution of rhythmic geomorphological features on the beach face and in the nearshore zone, 3) to test the prevailing hypothesis of edge wave-beach face interaction as the forcing mechanism for the initiation and growth of beach cusps and 4) to document and explain the short and long-term changes of the coastline.



The major geomorphological features that appear at fixed locations along the coast of the gulf are (from N to S) : longitudinal bars, welded bars and crescentic bars and beach cusps. The spacings of the rhythmic forms vary between 16 m and 170 m for longitudinal bars, 110 m and 330 m for welded bars, 110 m and 520 m for crescentic bars and between 3 m and 50 m for beach cusps. The dominant winds in the gulf approach from NW, SW and W and produce waves with maximum theoretical periods of 7.2 s, 11.4 s and 10.7 s respectively. Detailed wave refraction diagrams indicate the existence of a highly variable nearshore current system that gives rise to a complex sediment transport pattern with a divergence at the mouth of Alfios river and a convergence near the Raiafa lagoon.

For the field experiments, five selected locations along the coast were occupied intermittently over a period of three years. A microtopographic grid was established on the beach face at Kakovatos and was used to monitor the small scale morphological and beach slope changes associated with the evolution of beach cusps, to estimate the sediment flux and to produce accurate topographic and erosion maps of the beach face. Topographic cross sections at five locations along the coastline were measured regularly to monitor large scale changes. A computer-based data acquisition system, an anemometer, continuous-resistance wave staffs and specially designed drifters were used for the simultaneous measurement of wind speed and direction, wave height and period and nearshore current velocity and direction. Additional data on the nearshore water circulation were collected with the use of fluorescent dye. Time-lapse photography at 0.5 s intervals permitted the monitoring of run-up and the detection of subharmonic motions on the beach face, indicative of the presence of edge waves in the nearshore zone. All hydrodynamic measurements were analyzed with the use of time series analysis techniques. Grain size samples were collected systematically during measurement periods to determine the textural characteristics of the coastal sediments. The samples were drysieved and the results were analyzed by the method of moments.

The analysis of grid and cross section data showed that the beach was in dynamic equilibrium during the measurement periods with the formation of rhythmic shoreline features being due to a redistribution of sediment on the beach face without any net erosion or accretion.

The computed wave spectra showed that the maximum measured significant wave periods for SW winds were about 20% smaller than the theoretical ones. For W and NW winds there were no significant differences between measured and theoretically expected maximum wave periods.

The longshore current measurements as well as the longshore variation of the textural characteristics of the coastal sediments verify the sediment transport pattern indicated by the refraction diagrams.

A very significant element in certain wave spectra is the presence of infragravity waves with periods between 32 s and 54 s. The existence of these waves and edge wave activity in the nearshore zone have the potential to explain the formation of the observed crescentic and welded bars.

The initiation of beach cusps is associated to a reduction of sediment flux after a period of increased wave activity and to the presence of standing edge waves. In most of the cases, edge wave activity did not persist and cusps grew through the interaction between the incident waves and the initial perturbations on the beach face.

Cliff recession at Katakolo is due mainly to aeolian erosion and not to wave undercutting. Erosion rates up to 1.83 cm/h were measured during periods of strong SW winds.

Sediment Transport on the Continental Shelf of the SE Mediterranean Sea - Indirect Evidences

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More than 30 years ago, EMERY and NEEV (1960) proposed a model for sediment transport along the Israeli continental shelf. According to this model, which was based on the orientation of the Israeli coastline and the direction of the highest waves which may approach the Israeli coast (Az 275 - 292), longshore sand transport in the surf zone is directed northward from Rafah to Natanya, on the southern part of the Israeli coastline, whereas from Natanya northward the littoral drift is in a southward direction. As the source of sand is undoubtedly from the Nile, this model provided no explanation for the quartz sand found on the beaches north of Natanya. EMERY and NEEV therefore proposed an additional mechanism for sediment transport, namely the Mediterranean counterclockwise current, which carries sediment along the continental shelf from south to north and also feeds with sand the surf zone of the Israeli coastline. Recent findings may shed light on the validity of this part of the model.

In a study carried out by COLEMAN *et al.* (1981) off the eastern flank of the Nile Delta, bedforms such as sand ribbons and mega ripples were recorded by a side scan sonar. When a composite of these bedforms records was put together, their orientation indicated sand movement from southwest to northeast. Sediment distribution as well as current measurements supported this conclusion.

A side scan sonar survey carried out by GOLIK (1988) off Ashdod, Israel revealed the presence of small rocky mounds at a water depth of 90 to 105 m. These mounds (see figure) are 30 to 70 m in diameter, having a relief of 5-7 m, and are probably projections of a buried eolianite ridge. The records show a crescent shaped trench surrounding each of these mounds with the concave side of all of them facing to the northeast, parallel to the general orientation of the coastline. It is proposed that these crescent shaped trenches were formed as a result of bottom currents which exist in the area and cause sediment moment from the southwest to the northeast.

Between 1982 and 1990 nine surveys were conducted in the vicinity of the marine coal terminal off the Hadera power plant, aimed at monitoring the dynamics of coal particles which fall to the sea bottom during coal unloading (GOLIK and AVERBACH, 1985; GOLIK, 1986; GOLIK, *in prep.*). In all these surveys, the distribution of coal particles was that of a plume oriented northward, to a distance of at least 15 km, parallel to the coastline, at water depths greater than 13 m. South of the terminal, coal was very scarce. It is estimated that since the terminal started operation in 1981, some 10,000 tons of coal dropped to the sea bottom, yet underwater photographs, taken some 50 m from the unloading point, show that although coal is dispersed on the bottom, the seabed is not covered by a layer of coal as one would expect. The consistent presence of coal particles only north of the terminal, and the absence of a continuous coal layer under the unloading point, indicate that the net bottom currents' direction off Hadera is northward, and that they are strong enough to prevent coal accumulation there.

All the cases mentioned above, demonstrate that the general flow regime on the sea bed in the southeastern Mediterranean is oriented parallel to the coastline in a general northeast and northward direction. Recent current measurements which were conducted throughout the water column at several stations on the Israeli shelf by ROSENTRAUB (1990) also show that most of the time the currents flow northward. All these support the hypothesis of EMERY and NEEV concerning the sediment transport on the Israeli continental shelf.

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Littoral morphology and sediment distribution in the Ebro Delta (NW Mediterranean)

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The Ebro Delta is a fluvial wave dominated delta, with a surface of 325 km^2. Its 50 km long sandy shoreline is characterized by the presence of two spits which individualize lagoons to the North and South of the delta plain (MALDONADO, 1975). The microtidal nearshore depicts several bar and trough systems as the main morphological features. Coastal sediment erosion has been analyzed for a five years period (1988-1992), with financial support from the Autonomous Government of Catalunya. Each 4 months, bathymetric surveys and sediment sampling were performed in the littoral zone (0-15 m water depth).

Littoral morphology is controlled by the location of river mouths and the wave climate. Four major delta lobes were developed during the last centuries (MALDONADO, 1972; 1986). These lobes are located in the southern, northern, central and, the most recent, northeastern sectors of the delta plain (Fig. 1). The bathymetry shows that littoral slopes are gentle offshore abandoned lobes and steep in front of the presently active lobe and at both spit ends. A submerged platform is observed off abandoned delta lobes, which is deeper proportionally to the age of the lobe. Three types of littoral profiles have been recognized: (1) progradational profiles, located offshore the present river mouth and in the spit ends, where depositional processes are dominant; (2) erosional profiles, situated in the recently abandoned delta lobes, that are in an erosion-dominated evolution, and (3) equilibrium profiles, located in the more ancient abandoned delta lobes, where the processes of reworking and deposition are in equilibrium (Fig. 2). These littoral profiles allow also to differentiate two areas in the coastal zone separated by a sharp change in slope : (1) the nearshore area, with steep slopes is characterized by the bar and trough systems, which extend from the shoreline to 4-6 m water depth, and (2) the transitional area between the nearshore area and the inner shelf, which is smooth and gently sloped.

Littoral sediment distribution is closely related to delta morphology, sediment input and wave climate. The grain size of the nearshore deposits is medium sand (250 µm) (Fig. 2). The sand-mud transition normally starts in the sea-side of the more distal sand bar and the sediment becomes progressively fining toward the inner shelf. In progradational profiles, the sand-mud transition is sharp and is located close to the shoreline (4-7 m) (Fig. 2A). Erosional profiles are characterized by the presence of mud outcrops corresponding to ancient delta lobes and relict sand bars located offshore of the influence of the mean wave climate (Fig. 2B). In equilibrium profiles, the sand-mud transition is more widely spread and complex. In these profiles grain-size decrease between the distal sand bar and about 10 m water depth, without mud in this zone. Between 10 and 15 m water depth, mixed medium and very fine sand is present, probably as result of reworking of ancient nearshore and delta lobe deposits. From this zone toward the inner shelf, the sediment is progressively finer and mud is usually observed at about 20 m water depth (Fig. 2C). The wave climate is the main factor controlling the long-shore sediment transport from delta erosion and river input. It cause changes in the littoral slope and the across-shore sediment distribution patterns.

During this Century, sediment supplied by the Ebro River has been drastically reduced by dam construction, modifying the coastal evolution of the Ebro Delta (MALDONADO, 1986; PALANQUES *et al.*, 1990). Littoral profiles have a tendency towards the erosion-dominated type and a landward migration of the shoreline, while sandy deposits are eroded and transported both offshore to deeper areas and landward infilling the coastal lagoons. During periods of low fluvial sediment input, as the 1988-1991 period, coastal erosion increase and littoral sediment becomes progressively coarser, because the finer-grained fractions are transported offshore.

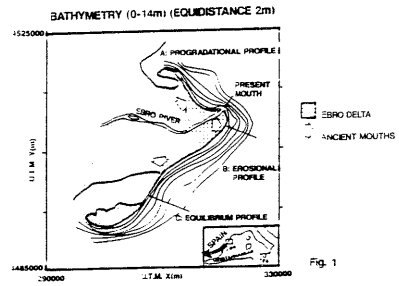

Fig. 1

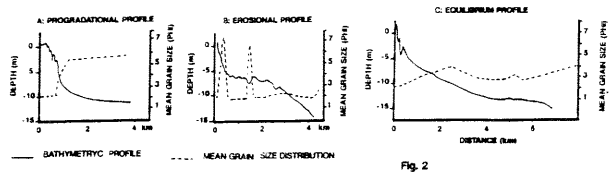

Fig. 2

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Shoreline evolution of the Ebro Delta: seasonal and medium-term evolution

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The Ebro Delta, located in the Spanish Mediterranean coast (fig.1) has experimented during the last decades a change in its evolution trend. Whereas in 1900 it behaved as a progradating coast it is eroding severely at present. This change is linked to a decrease of the solid discharge of the Ebro river while the transport capacity of the waves has remained much the same.

Under these conditions, the behaviour of the Delta can be assumed as independent of the river discharge and fully wave-dominated. This means that marine dynamics is responsible for the short-term and medium-term coastal responses.

The Delta coast has been monitored during the last four years to identify and quantify the processes that control the coastline evolution. From these measurements, two types of changes have been identified: medium-term and seasonal changes. The first ones are associated to longshore transport gradients along the coastline (JIMENEZ *et al.* 1991a, JIMENEZ *et al.*, 1992) while the second ones are due to the quasi-cyclic action of storm and post-storm waves. These changes are overlapped and can be seen in figure 2.

The existing of longshore transport gradients - due to changes in the wave characteristics at breaking and to differences in the shoreline alignment - produce erosive processes in some coastal stretches (figure 1). The main erosive areas are the Buda Island and the Trabucador Bar in the southern hemidelta, and the whole northern hemidelta. Their behaviour can be classified as a medium-term trend because of the time scale of the measurements (several years), but seems to be representative of the longer-term evolution trend (only from the wave action point of view, i.e. not considering other kind of effects like sea level rise or others).

The profile short-term changes are associated to the storm and post-storm wave attack on the coast and they are correlationed with the climatic seasons -heavy storms during the winter and mild waves during summer- (GARCIA *et al.*, 1992). These changes are mainly due to the cross-shore component of the transport and they are not uniform along the coast. The response of each profile depends on the coastal orientation with respect to the wave direction. Coastal stretches with a similar behaviour can be easily identified (JIMENEZ *et al.* 1992).

In the Trabucador Bar the most remarkable short-term changes are associated to storm events during which high waves coexist with an important surge. If overtopping is produced, a remarkable sediment transport towards the Alfacs Bay can exist. This transport can produce the failure of the Bar. The sediment removed from the littoral and deposited it in the Bay, will be no longer available for the littoral transport scheme (JIMENEZ *et al.*, 1991b).

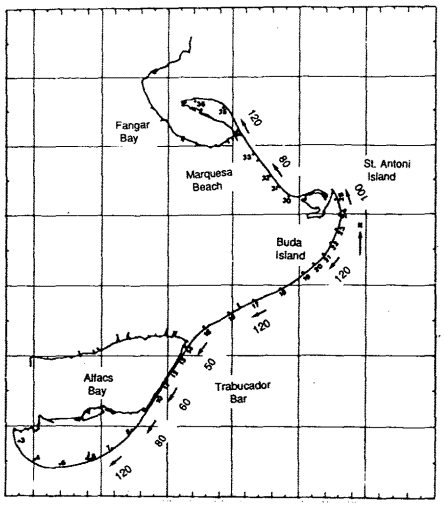

Figure 1. Net longshore transport rates in the Ebro Delta (transport in thousands of cubic meter per year)(modified from Jiménez *et al.* 1992)

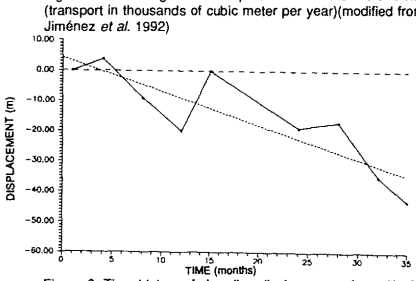

Figure 2. Time history of shoreline displacements in profile 22 (Buda Island).

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Sedimentation in the Rasa River estuary (Istra, Croatia)

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The Rasa River estuary (Istra, Croatia - see: Figure) was chosen as a model of karstic river mouths in studying the land/sea interaction. The principal vehicle of this interaction are suspended mineral particles and consequently their sedimentation. The particles originate from the northern part of the drainage basin, where Eocene flysch sediments are exposed. The southern part of the drainage basin and the whole estuarine system are developed in Cretaceous carbonate rocks.

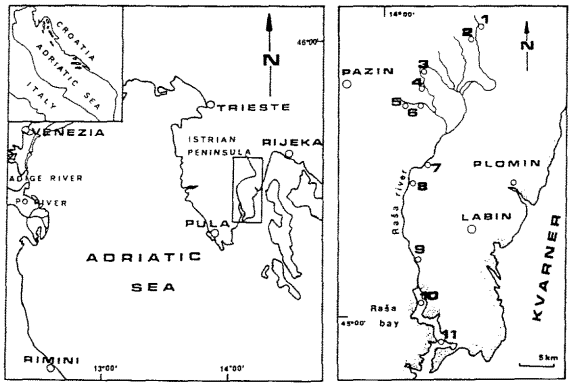

Figure: The Rasa River estuary and the sampling stations

The hydrology of the Rasa River is typically karstic : small flux with high seasonal variations : at sampling station (ST 7) the reported mean flux is 2.3 m^3/s, whereas at the river mouth (ST 10) the corresponding figure is 12 m^3/s.

Sampling in the drainage area includes terrestrial sources (ST 2, 3 and 5), riverine sediments (ST 1,4,6,7,8, and 9), and estuarine (sea) sediments (ST 10 and 11). The results of sedimentological analysis of these samples are presented in the Table.

Standard techniques have been used in producing data shown in the Table: X-ray diffraction for semiquantitative mineral composition ; gas volumetry for carbonate share ; nitrogen adsorption for the BET surface area determination ; standard wet sieving and Coultercounter sizing for granulometry.

TABLE : Characteristics of materials

	Sampling station	Mineral composition*	Carbo-nates %	SSA m^2/g	Mz µm	Rock/soil type
	2A	Ca, Q, F, I, Ch	62	2.6		sandstone
	2B	Ca, Q, I, Ch, S, K, F	46	10.9		marl
	2C	Ca, Q, I, Ch, F	51	12.8		marl
I	3A	Ca, Q, S, I, Ch, F	39	14.6		marl
	3B	Ca, Q, F, I, Ch	52	5.3		sandstone
	5	Ca, Q, I, S, Ch, F	46	8.2		marl
	1	Ca, Q, Ch, I, S, F, K	38	16.2	6.7	clayey silt
	4	Ca, Q, I, Ch, S, F	28	26.5	8.1	clayey silt
	6	Ca, Q, I, Ch, S, F	46	15.0	6.0	silty clay
II	7	Ca, Q, I, S, Ch, K, F	28	25.5	3.5	silty clay
	8	Q, Ca, I, S, Ch, K, F	19	30.5	3.0	silty clay
	9	Ca, Q, I, Ch, S, F	39	8.7	3.6	silty clay
III		Ca, Q, I, Ch, S, F			3.0	silty clay
	10	Ca, Q, I, S, F, Ch	38	10.0	3.7	silty clay
IV	11	Ca, Q, I, Ch, D, F	32	13.3	4.3	silty clay

The mineral composition of the clastic source rocks is predominantly carbonate, but noncarbonate, quartz and clay minerals are present in significant shares. The latter are the minerals found in riverine and estuarine sediments due to its transport from its flisch origin through the carbonate zone into the estuary. The main part of the terrigeneous clastic particles is deposited in the estuary. The Rasa River estuary is an illustrative example of transport of suspended matter and sedimentation under the influence of the Coriolis force, as indicated by the high turbidity of water at the right bank. The main reason for accumulation of terrigeneous material is the estuarine circulation with the ingoing bottom saline water and outgoing surface brackish water. The foregoing is corroborated by studies of BENAC*et al.* (1991) of the Rasa River basin, and by JURACIC and PROHIC (1991) of the Krka River estuary.

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Coarse sediments in the Eastern Mediterranien

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Coarse edaphogene material within the deposits of slopes and foots of large positive structures of the Mediterranien Sea bottom was studied by cores up to 350 cm long located along seismic profiles, which run through the West Tartus Ridge and Anaximander Mountains (Training through research cruise, R/V "Gelendzhik", 1991). Under the recent oxidated mud cover large fragments are encountered in the deposits of Early Holocene and Wurme age practically pervasively in the form of single inclusions, admixtures up to 25% and individual accumulations containing varying quantity of carbonaceous-clay matrix.

With regard to roundness clasts and size grus and gravel (0,1-1 cm), scree debris and pebble (1-10 cm) are encountered within fragmental components. Depending on the proportion of these components, gravel-grus deposits, breccia, conglomerates and breccia-conglomerate are described. The most widely developed are coarse clastics composed of the material subsynchronous to Holocene and Wurme deposits. Usually, such accumulations are represented by clay breccia-conglomerate of landslides from the slopes. Scree debris of carbonaceous micritic crusts which have been likely broken on the bottom surface due to the movement of underlying sedimentary masses constitute a considerable part of the clastics. The more rarely encountered are fragments of redeposited sapropel.

In the deposits of several cores coarse material was found, which was more ancient than that of Quaternary age. So, breccia occurs at the depth of 2326 m in the deposits of the trench South-Westwards of the crest Anaximander Mountains within the interval of 27-45 cm from the bottom surface. Alongside micritic-carbonaceous and clay fragments, subsynchronous to Late Wurme time, the breccia contains flattened acute angular fragments of terrigene and carbonaceous bedrock. Among greenish terrigene fragments aleuritic-micaceous compacted clay and graywacke sandstones have been identified. The graywackes are composed of quartz-chlorite-carbonate altered rock, the products of dezintegration. One of the carbonaceous rockfragments is represented by intrabiosparite of shelf-facies genesis, where Y.Y. ZAKREVSKAYA has identified *Nummulites* ex gr. *globulus* Leym. and *Discocyclina* ex gr. *nummulitica* Gimbel of Eocene age. Another fragment of limestone is referred to biosparite and composed of Foraminiferas, where V.G. KOURENKOVA has identified *Orbulina suturalis* d'Orb., *Globigerina bulloides* d'Orb., *Globigerinoides* sp., *Globorotalia* sp. of middle Miocene and Pliocene age. The fragments of dark-coloured carbonaceous-argillaceous-carbonate rock of the same age are found in the deposits of the lower part of the South-Eastern slope of the West Tartus Ridge (the depth is 1515 m) within the interval of 160-168 cm from the bottom surface.

It is characteristic that the breccia with fragments of Tertiary bedrock occurs above accumulations of coarse clastics, subsynchronous to Wurme deposits. This evidences that relief-forming processes took place even till Late Holocene period, due to progressive development of tectonic movemenets, causing first relict silt sliding and redeposition and then the desintegration of the bedrock of upheavals and trench slopes.

Study of the soil deposition on the river Seman Mouth by the use of Cs-137

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Albanian rivers every year transport in suspension to the sea about 50 million tons of sediments (1). Depending on this and on the elements in the hydrological regime of the near shore part of the Adriatic sea, the sea shore line has changed considerably and erosion and deposition parts are formed. One of such deposition part is that of the river Seman mouth. The soil here is salty and does not tilled agriculturally.

Our aim was to determine the mean depth of the depositions in the northern part of this mouth (Fig. 1). We have choosen three points. The distance between points P1 and P2 is about 250 m, while that between points P1 and P3 is about 100 m. The three points are about 1.5 km far from the seashore line.

The method used was that of Cs-137. Cesium, after being in touch with soil, is strongly absorbed and later movements of this radio-nuclide are mostly due to the physical movement of the soil particles (2). In ref. (3.4) cases are given were this radionuclide is used in the soil erosion studies.

Cs-137 is one of the main products of nuclear fission because of its relatively high yield. 5.57 nucley are formed every 100 fissions (5). By calculations we find that, during fission of the nucley in an installation with 1 Mt fissionable energy, the produced Cs-137 activity is 5.88E+09 MBq. The high value of cesium depositions takes place one year later than the explosion.

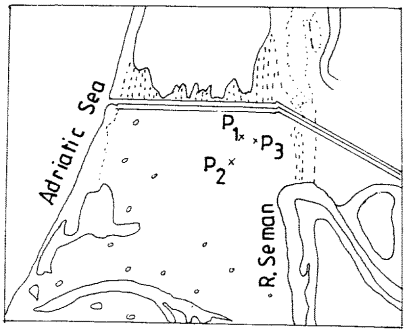

Fig. 1 The position of the points of the study

At the three points we digged up holes of 2 m depth. In the first two holes, in November 1986, the soil samples were taken 5 cm thick, while in the last, in June 1987, 2.5 cm. The samples were dried in 130°C, then they were ground in a mill and sieved through a 100-µm sieve. About 500 g of material was placed in a marinelli beaker to measure the activity. The system used was a gamma-spectrometric one. It consists of a Ge-Hp detector, a 4000 channel analyzer and a IBM XT microcomputer.

The dependances from the depth of the Cs-137 activity in Bq/kg are shown in Fig. 2 and Fig. 3. At the three points, beyond the depths 190 cm, 100 cm and 135 cm, respectively, the material was mainly sand. The respective measurements were excluded. The depths of the soil from the surface to 5 cm are distinguished by a high activity of the Cs-137. This is due to the Chernobyl accident in April 1986. This pollution can be used as the time reference point in cases when the depositions are to be determined. Beyond this depth the quantity of this nuclide increases. The oscillations of the values of Cs-137 can be explained both from the quantity of the Cs-137 that fallout has deposited on the zone of the river in a particular year and from the oscillations in different years of the sediments transported in suspension.

The highest value of the Cs-137 is obtained at 137 cm depth for point P1 and 130 cm for point P3. These depths correspond to the depositions of the year 1963, one year after the maximum of the nuclear explosions. The point P1 in 1957 was between 1 m and 1,5 m under the sea level. This we found from the maps compiled before 1960. At these depths a small part of the sediments was deposited on the sea-bed. The depositions mostly took place at the less depths. They were small when the points were above the sea level and happened when the river gushed. The maximum of Cs-137 at the 180 cm depth corresponds to the depositions of 1955, one year after the peak of nuclear explosions of 1954. At the point P1, the mean annual deposition from 1955 to 1963 is 5 cm and from 1963 to 1986 is 6 cm. After 1963 the depositions are more extensive, the sea is more shallow, so, after about 5 to 10 years this point would be at the sea level.

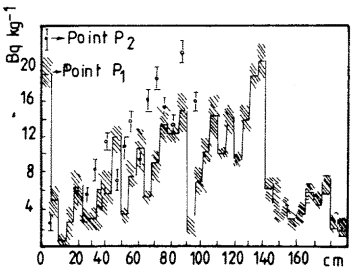

Fig. 2 The dependances of ^{137}Cs activity from the depth, points P1 and P2.

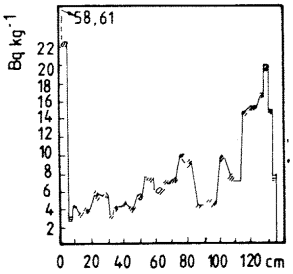

Fig. 3 The dependance of ^{137}Cs activity from the depth, points P3.

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Channelised deep sea depositional systems in the Mediterranean : a plan view perspective

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GLORIA sidescan sonar data from along 30,000 km of continental margin, worldwide, provides sufficient data for a new classification of deep sea "turbidite systems". The scheme is based on data for slopes with a fall of 3000 m or more. The plan view emphasis is a valuable complement to sequence stratigraphic schemes that are derived mainly from study of seismic profiles and rock outcrops. The simplest classification is into a spectrum of types, distinguished by their channel and lobe characteristics, in which the main control is the long term rate of sediment input. Long term rate of input will be affected by drainage basin size and gradient, and by climate, to a greater degree than to sea level. Thus a spectrum of sequence stratigraphic models is required for this range of types.

The model is tested for the Mediterranean using both published information and new GLORIA data from the Rhone Fan, from west of Corsica and Sardinia and from the Alboran Sea.

The model requires the mature, highest input types to have a point source, a large radial distributary channel system with sinuous channels and low fan gradients. Sinuosity should be greater than about 1.6 in the middle reaches of channels and maximum channel gradients should be less than about 1 in 100. Width to depth ratios are usually less than 50. Sandy lobes are expected to be attached to the ends of the channels. Flows are frequent, possibly in excess of one a year.

Mature lowest input types have a tributary feeder system and a lesser development of, or no, channel-levee systems. Channels are straight, maximum channel gradients are usually greater than 1 in 70 and width to depth ratios can be greater than 150 near channel ends. Channel mouth lobes and basin plains are common and relatively extensive and lobes can be detached from their channel. Flows are infrequent, possibly less than one every 1000 years.

A frequency distribution shows that there is only one of the highest input types in the Mediterranean, the Nile Cone, and that the great majority are low input systems. Thus one can predict from the model that straight channels should be the norm in deep sea depositional systems rather than the more spectacular looking sinuous channels that receive much of the attention.

The Nile Cone is the largest of the Mediterranean systems with a drainage basin of over 2 million km2. There are probably two main sites of input, feeding the Rosetta and Damietta Fans. However it differs considerably from the perceived ideal for a high input fan (e.g. the Indus and Amazon systems), presumably due to tectonic influences. In addition to salt tectonics on the eastern fan surface the deeper fan sediments are being incorporated into the Hellenic Ridge accretionary complex, resulting in the unusually wide fan shape. Limited GLORIA coverage shows that although it has a radial pattern of sinuous channels (KENYON *et al.*,1975), there is no well developed distributary pattern and few avulsions. Sinuosity is less than 1.8, channels are relatively small (less than 20 m deep) and width to depth ratios of >50 are measured. Gradients are higher than the norm (maximum channel gradient >1 in 50).

The Petit Rhone system is close to the norm for a medium to high input type. The drainage basin is about 100,000 km2 and there is a distributary pattern with at least one avulsion (e.g. O'CONNELL *et al.*, 1991). Maximum channel sinuosity is over 2 for the abandoned channel but is only about 1.4 for the newly avulsed and entrenched channel. It is predicted that channel sinuosity will increase as a new channel-levee system is built out from the point of avulsion across the "neofan". The fan is fed by a single relatively steep gullied canyon. The maximum channel gradient (about 1 in 20) is geater than usual for such systems. A medium to low input type is exemplified by for instance the Var and other Provencal systems. The Var system has a drainage area of about 4,000 km2. It is fed by very steep tributary canyons, maximum gradient of about 1 in 5. The channel is relatively straight and wide (up to 7 km) and has a 60 km long levee along its right bank whose location is affected by Coriolis forces. Downslope from the leveed section the channel continues to an unusual bifurcated termination where the channel depths are only 2 m or so.

Low input types are exemplified by the tributary canyoned systems to the west of Corsica and northern Sardinia. These have subaerial drainage basins of less than 1,000 km2. Straight, unleveed and wide channels, with a width to depth ratio of >100, terminate at or just beyond the base of the steep slope. Maximum channel gradients are greater than 1 in 10. The floors of these channels are rough and have high acoustic backscatter, that is believed to be due to the passage of fast moving turbidity currents (first observed off north Africa near the site of the Orleansville earthquake by BELDERSON *et al.*, 1970). On the rise beyond the channel mouths, and above the flat basin plain, there is a pattern of strongly backscattering braid like bars that are up to 15 km long, with a relief of less than 2m. These are suspected to be sandy deposits and may represent a detached lobe, however it is not known whether they result from more than one turbidite event. A 7 m thick transparent layer, 4 m beneath the surface of the Algero-Balearic basin plain, may be a mega turbidite that represents a major depositional event.

The scheme does not hold up well on shallow margins, for instance the Po system has filled its confined basin, or on uplifted margins where the systems cannot achieve a graded equilibrium, for instance the Nile Cone. On the northern margin of the shallow Alboran Sea, with a fall of <2000 m, there are single channels, the Andarax system and another off Marbella, that are unusual in having a higher sinuosity than is normally found on slopes of such high gradient. The very small, straight channelled Crati system (COLELLA and NORMARK., 1984) does not reach the base of slope, perhaps because it is not large enough to bypass the compressional ridges on the southern Calabrian margin.

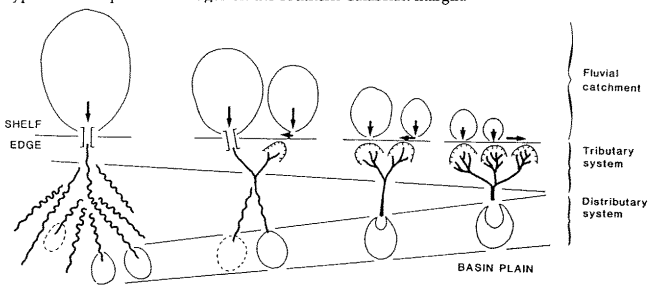

Fig. 1 Simplified classification of channelised depositional systems on continental margins.

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The concept and the estimate of the receiving capacity of the Northern Adriatic for contaminants

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The problems of preservation and management of the marine environments require profound knowledge of the mechanisms governing the transport, chemical and biochemical modification, and deposition of a contaminant, or a multiple of these. Problems of identification of the most important contaminant and its potential danger of becoming a critical pollutant have been amply investigated in recent years (DEGOBBIS, 1989 ; DEGOBBIS and GILMARTIN, 1990). Historical data are particularly relevant to understand the influence of terrestrial run-off (FONDA UMANI *et al.*, 1989).

The Northern Adriatic is an extended coastal area of a semienclosed sea whose major problem are land-based sources of contaminants. The involved problems of understanding the mechanisms of transport are exemplified by the complex circulation patterns in space and time (CEROVECKI *et al.*, 1990). Along with studies done by other authors on the hydrodynamics and hydraulic transport phenomena, extensive studies have been undertaken in recent years on several small and medium size Adriatic river mouths, the Krka, Adige and Rasa (PRAVDIC and JURACIC, 1988; BOLDRIN *et al.*, 1989; JURACIC and PRAVDIC, 1991; SONDI *et al.*, 1992).

The results of such investigations show that the suspended particulate matter is a selective and important vehicle for the transport of contaminants from land to sea. Major efforts were expended in quantifying this influence and understanding the mechanisms of transport and deposition. It has been shown that some previously overlooked properties of both the suspended mineral particles, of the amount and nature of the organic coating, and of the nature of the contaminant can determine the extent of the influence. For the Krka River the results indicate that most contaminants are bound to particulates and deposited within the estuary. All indicators show that for the Adige River mouth the mechanism is, in general, twofold : for lead, nickel and chromium there is immobilization by adsorption and sedimentation within the estuary ; copper and cadmium are predominantly transported into the marine environment.

Results of such studies indicate that in assessing the assimilative capacity of the Northern Adriatic as a tool of rational environmental management, and in particular the decisions on the extent of prevention of pollution from land-based sources will require further studies at specific sites, and a thorough investigation of the interaction between dissolved matter and particulates, and between suspended matter and sediments.

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Structure of the Eastern part of the Cyprus Arc

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During the first "Training through Research" cruise (*R/V "Gelendzhik"*, 1991) the eastern part of the Cyprus Arc was investigated by gravity and magnetic survey, as well as high resolution seismics. Two- and three dimensional gravity modelling of the intensive ΔG_B anomaly over Cyprus has been fulfilled on the base of data already available and newly obtained. The modelling allowed to define a position of the main density boundaries in the Earth's crust and geometry of the anomaly-forming body. The results of gravity modelling, justified by accompanying magnetic modelling, show that a large ophiolite body has been emplaced here into continental crust. The lower body boundary is situated at the depth of about 10 km, the upper boundary rises from east to west from 9.5 km depth and outcrops as the Troodos Massif in Cyprus. West of Cyprus this ophiolite body is cut by a deep fault.

The modern southern boundary of the Turkish Plate in the studied area passes between Cyprus and Eratosthenes Rise, along the Hecataeus Ridge south flank and its eastern continuation, the West Tartus Ridge, that has been traced till the Syrian upper continental slope. A pattern of gravity field, thickness and composition of the Earth's crust and mode of sedimentary cover deformation change sharply across this plate boundary.

No signs of subduction of the African lithosphere have been recorded along the West Tartus Ridge. The ridge was interpreted as a large steeply south- and southeastward thrusted sheet likely to be made up of the Palaeogene sedimentary rocks (Fig. 1). The Messinian evaporites pinch out against the ridge slopes. The similar but not so extensive thrust structures were found to the North, between the West Tartus Ridge and underwater prolongation of the Kyrenia Ridge. This system of southward thrusts orlginated possibly in the Oligocene-middle Miocene time, when the convergence of the African and European Plates was northwest directed (LETOUZEY, TREMOLIERES, 1980; RICOU, 1980; LIMONOV *et al.*, 1992). Since the late Miocene time, when the convergence direction became northeasterly, the thrust sheets suffered a lateral displacement along the wrench fault system stretching from Cyprus (BAGNALL, 1964) to Syria to form step-like configurations of their coastlines. All shear sheets are moving in general to the west, the value of westward displacement decreasing gradually from the southern sheet to northern one. Small pull-apart basins were formed inside some sheets due to latitudinal separate ophiolite bodies, rest on the deep fault (possibily deep dextral wrench fault) traced approximately from the Nile Delta into the Antalya Gulf. As a result of such kinematics the lateral crust shortering and ophiolite piling take place, reflected in intensive gravity high over Cyprus.

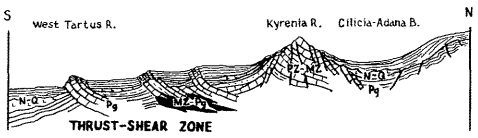

Fig. 1.- Schematic geological cross-section of the Cyprus Arc along 34°40'E.

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Shallow-water vs deep-water depositional model - A new interpretation of Lower to Middle Miocene salt formations of the Carpathian foredeep molasses.

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The Carpathian foredeep is a typical syn- to late orogenic, mainly epicratonic (peripheral) foreland basin of Late Alpine age. The origin of this foreland basin is due to lithospheric flexure in response to loading by multiple overthrust sheets. The basin is filled with thick sequences of siliciclastics containing evaporite units. The source areas of the molasse-fill where the rising and growing accretionary prism of the deforming Carpathians and/or the rising compensation wall landwards of the basin.

The basin is generally divided into two subbasins : the internal and external ones, the first being now buried beneath, the second - in front of the thrust belt. Within the first, molasse sedimentation start in Egerian (Late Oligocene to Aquitanian) and terminated in Lower Badenian (Langhian) time. These form the lower molasse complex of authors (e.g. VIALOV, 1965). Within the second, sedimentation start in Lower Badenian and terminated in Upper Badenian (Serravalian) time to the W (Moravian sector) or Pannonian (Tortonian) time to the E and SE (Ukrainian and Roumanian sectors) of the foredeep basin. These form the upper molasse complex of authors (e.g., VIALOV, 1965).

For the upper molasse complex a shallow-water, marine to deltaic depositional system is commonly accepted and will not discussed here. But for the lower molasse complex of the internal subbasin no general accepted depositional system exist, although most authors agree that sedimentation start in a deep-water environment (e.g. , OSZCZYPKO, 1982). The lower molasse complex is composed of three successive sequences which overlap each other in a prograding, transgressive manner and are separated by erosional and/or tectonic unconformities. Within each of these salt-bearing units, including potash-salt lithosomes occur. For these the classic evaporative genetic model is accepted. Consequently, a shallow-water to coastal sabkha or continental playa depositional system for at least these units is accepted. The presence of rip-up breccias, dessication cracks, potash-salt lithologies, bird and other land-animal footprints apparently confirm this model.

However, paleontological, both paleobotanic, macro- and microfloral and paleozoological data on terrestrial great mammals point to a warm and humid, sometimes even wet climate during the Lower and early Middle Miocene time, i.e. during the whole time of the deposition of the salt units within the successive molasse sequences cited. There are other aspects of the geologic setting, lithology, mineralogy and geochemistry of the salt units which are in many respect quite unusual : (1) they pass laterally, towards the deformation front, into syndiastrophic offscraped, coarse-clastic flyschoidal or flysch deposits of the final miogeoclinal or initial foredeep throughs ; (2) they overlap transgressively the peripheral (landside) slope of the outwards migrating molasse basins ; (3) they commonly presents features of redeposited sediments, i.e. of olistolithic, olistostromic, submarine slump or debris flow and turbiditic deposits ; (4) they are composed of zubers, i.e. clay/halite mixtures with halite saturation index values of 0,1 to 0,4 only ; (5) potash-salts occur as intercalations or irregular bodies at any plane within the whole vertical section of the individual salt formations ; (6) the bromine profile through halite sequences are irregular, not smooth, decreasing, not increasing upwards ; (7) the salts posses abnormal hight concentration of Ba and Sr ; (8) within the salt formations normal marine metazoans are quite common. All these pecularities suggests that salt-bearing units within the successive molasse sequences filling the internal subbasin of the Carpathian foredeep basin are not of evaporitic origin. They were formed as precipitates from superconcentrated formation brines expulsed from the deforming and thrusting accretionary prism and from hyperconcentrated dissolution brines resulting from subrosive leaching of tectonically canibalized older salt units of the preceeding molasse sequences underplated along the decollement surface (LISZKOWSKI, 1989). The salts were deposited at relative great depths ranging from approx. 300 to 600 metres. The depositional and postdepositional structures that apparently are suggestive for a shallow-water to supratidal-lagoonal or saline depositional subenvironment can be equally good or even better interpreted to support the suggested deep-water depositional model : the apparent rip-up breccias and desiccation cracks are syngenetic and/or eodiagenetic structures resulting from hightenergetic seismic pulses which accompanied the thrusting process, potash-salts were the result of precipitation from hyperconcentrated dissolution brines e.t.c.

The suggested genetic and depositional model for the Lower to Middle Miocene salt formations discussed challenge the whole depositional system of the lower molasse complex of the Carpathian foredeep into an extremely dynamic, orogenic sedimentation model. According to this model all their elements : spatial-time facies distribution and succession, lithologies, basin depth and subsidence ratio, thicknesses, sea-level changes, time of deposition initiation and termination e.t.c. where controlled by the timing, rate and intensity of the thrusting process.

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The Crustal Structure and Tectonic Implication of the Westernmost Mediterranean Derived from Geophysical Studies

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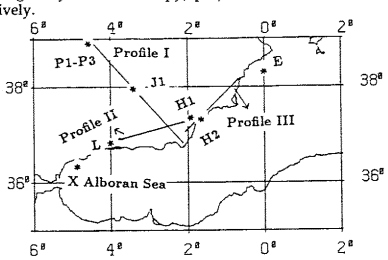
In autumn 1989 a wide angle reflection and refraction seismic (WARRS) survey was carried out in the Betic Cordillera by the Institut für Geophysik, Universität Hamburg and the Instituto Jaume Almera, Barcelona. The figure below shows the location of the shotpoints and recorded profiles. Three quarry blasts (P1P3), four landshots (J1, H1, H2 and L) were recorded along three profiles. In addition, two seashots (X, E) fired during the ILIHA (Iberian Lithosphere Heterogeneity and Anisotropy) project were also recorded along profile II and profile III respectively.



Profile I is about 270 km long and spans from the Iberian Massif to the External and Internal Betics. The results of the ray-tracing modelling, controlled by synthetic sections, show that the lower crust of External Betics consists of two layers. The upper part of the lower crust has a velocity of about 6.4 km/s which overlies a layer with a velocity of 7.0 km/s. In contrast to this, the lower crust in the Internal Betics seems undifferentiated, having a velocity of 6.6 km/s - 6.7 km/s. The Moho has a depth of about 36 km in Iberian Massif and deepens quickly down towards the transition zone between the External and Internal Betics, where the Moho is found at about 43 km depth and the high velocity layer (7.0 km/s) disappears. SE of the transition zone the Moho rises towords the Alboran Sea. The lateral variation of the crustal structure described above suggests that the crust belongs to different crust domains. The External Betics with a lamellae of high velocity (7.0 km/s) in the lower crust belongs to the passive continental margin of the Iberian Plate, while the Internal Betics belongs to the Alboran Domain. Such a lamellae with high velocity of 7.0 km/s in the lower crust is also found in the Valencia Shelf (MAUFFRET *et al.* 1992). MAUFFRET *et al.* (1992) proposed that the formation of this lamellae in the lower crust may be related with a Jurassic extensional event.

Profile II, lying in the Internal Betics and runing WSW-ENE, shows the existence of a prominent reflector at 9-13 km depth between the upper crust and the lower crust. The Moho is found at 38 km depth in the center of Profile II and rises towards east and west.

Compaired with Profile II, profile III (SW-NE) lying in the easternmost Internal Betics shows totally different features. The crust here is undifferentiated. The reflector between the upper and lower crust is absent. The Moho depth varies from 25 km in NE to 27 km in the center part and rises again towards SW. At the SW end of profile III the Moho is only 19 km deep. It is much shallower than the Moho under H1 (30 km) though the distance between the both is only about 20 km! These features may be caused by the Betics Sinistral transcurrent shear zone from Almeria (SW) to Alicante (NE) which may be associated with its extensions to the northeast (Balearic Islands fringe) and to the southwest (Eastern Rif in Morocco) as proposed by DE LAROUZIERE *et al.* (1988). The residual Bouguer anomalies seems to verify the presence of the transcurrent shear zone described above.

Furthermore, the WARRS results were also controled by gravity-modelling using the new terrain corrected Bourger gravity maps.

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Sédimentation et Géochimie sur un site conchylicole méditerranéen : La baie du Lazaret en rade de Toulon (Var)

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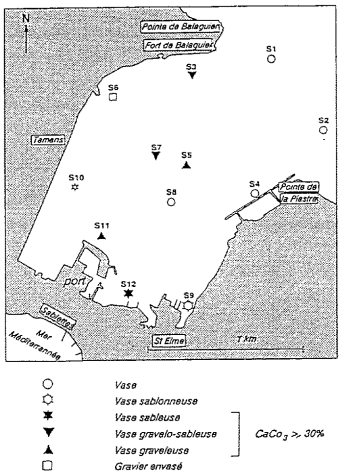
La baie du Lazaret, dans le Sud de la rade de Toulon, est un plan d'eau de 2 km² environ, ouvert aux houles d'Est. Ce site est le premier producteur de moules du Var. A ce titre l'IFREMER en a évalué, en 1989, la qualité du milieu marin.

L'un des objectifs a été d'identifier le rôle joué par les sédiments en tant que piège et source de contamination vis à vis des exploitations conchylicoles locales. Douze points de prélèvements superficiels ont été répartis sur l'ensemble de la baie (S1 à S12), cinq d'entre eux ont également fait l'objet d'un carottage pouvant atteindre 75 cm de profondeur dans le sédiment.



Classement granulométrique des sédiments superficiels dans **la baie du Lazaret**

La synthèse des analyses granulométriques et géochimiques apporte des précisions sur **les caractéristiques hydrosédimentaires et le niveau de contamination** prévalant en baie du Lazaret.

On y observe **un gradient de particules fines contaminées (PCB, Pb, Zn, Hg) depuis l'entrée vers le fond de la baie** qui se traduit dans les taux de silt (92% en S2, 29% en S12) et les indices de contamination chimique (5,4 en S2, 2,8 en S12).

Ces dépôts apparaissent (cf communications de ARNAL & ARNOUX) comme faiblement contaminés (Hg, Pb, Zn, Cu) ou en état de contamination chronique significative (hydrocarbures et PCB) et constituent, sur une épaisseur de 15 ± 5 cm selon les carottes, **un stock de contamination que l'hydrodynamisme local tend à piéger dans la baie.**

En effet, venant de la rade de Toulon, il existe **un courant de Nord-est** qui longe la corniche de Tamaris et vient s'amortir au fond de la baie en créant **une cellule de décantation au centre du plan d'eau**. Occasionnellement **renforcé par la houle au cours d'une tempête de vent d'Est**, ce courant remet alors en suspension les sédiments superficiels à l'entrée de la baie et vient s'en décharger en fond de baie pour les plus grosses particules (les moins polluées), au milieu de celle-ci pour les particules les plus fines (les plus riches en matières organiques et les plus polluées).

Cette dynamique hydrosédimentaire se traduit par :

- une fraction grossière dominante relativement moins envasée qu'ailleurs (silts <50%) **sur la bordure Nord-Ouest** (S3, S6),
- une sédimentation prononcée et plus contrastée **en fond de la baie** (sablons en S9 et S10, sables et débris coquilliers en S12), des remaniements intermittents de la couche superficielle liés à la navigation, la présence de mattes de posidonies dégradées ou mortes (S10) et une contamination chimique liée à des apports ponctuels (Zn, Hg),
- **une forte sédimentation dans le centre de la baie, amplifiée par la présence de tables mytilicoles** qui favorisent des dépôts gravelo-sableux envasés dans la partie Nord-Ouest (S7), sablonneux très envasés dans la partie Sud-Est (S8). **Des biodépôts** viennent s'y ajouter **sur une épaisseur de 35 cm** (S7) comme le montrent les rapports C org/N plus faibles ici (7,8 en S7) qu'à l'entrée (17,3 en S3) ou en fond de baie (18 en S10). La présence de *Clostridium* sulfito-réducteurs jusqu'à une profondeur de 50 cm, de germes-tests d'origine fécale et d'une surcontamination chimique témoignent ici du **rôle bioaccumulateur** des féces et pseudoféces produits par les coquillages.

Un chenal de navigation recoupe les deux zones précédentes (S5, S11). Son dragage épisodique et le passage permanent de navires en remanient les dépôts superficiels plutôt grossiers (grain moyen de 2,5 mm) et relativement peu envasés (environ 30%). L'hétérogénéité marquée de la carotte S11, tant en ce qui concerne la granulométrie que les paramètres géochimiques, suggère d'ailleurs une sédimentation à phases multiples.

Cette étude met ainsi en évidence **les rôles conjugués de la dynamique hydrosédimentaire** qui opère une redistribution des contaminants à travers la fraction fine, et **des exploitations conchylicoles** qui favorisent leur piégeage. **Les dépôts superficiels deviennent alors une source potentielle de recontamination du milieu marin en cas de conditions météorologiques défavorables** (vents d'Est).

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Upslope turbiditic sedimentation on the South-Eastern flank of the Mediterranean ridge

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Piston cores recovered on the outer deformation front of the Mediterranean Ridge (cruises BAN-82 and BAN-84 of R/V *Bannock*) on the Sirte and Herodotus abyssal plains allowed to study in detail turbiditic deposits of Pleistocene and Holocene age with composition clearly showing a provenance from the African continental shelf.

Turbidites were correlated up-slope in different cores and it was suggested that turbid flow coming from the African slope can climb the outer flank of the Mediterranean Ridge after crossing the Sirte and Herodotus abyssal plains during low sea level stands (CITA *et al.*, 1984a; RIMOLDI, 1989). If the turbidites had been deposited on a more or less flat abyssal plain and were later uplifted on the ridge by tectonic movements, unrealistic outward growth rates of 20-60 cm/year and uplift rates of 0.5-1.5 cm/year must be invoked. The grain size distribution and the composition of the Bronze Age Homogenite triggered by the caldera collapse of Santorini also indicated a similar depositional behaviour (CITA *et al.*, 1984b).

Sedimentologic and textural characteristic common to all these turbidites are:

1) Large thickness in the abyssal plains (over 9 m) and lateral continuity of several kilometers. For this reason these deposits can be classified as Mega-turbidites according to BOUMA (1987).

2) Thickness decreasing upslope on the southern flank of the Mediterranean Ridge.

3) Percentage of coarse fraction increasing upslope on the southern flank of the Mediterranean Ridge.

4) Composition of biogenic and terrigenous fraction indicating African shelf provenance.

Detailed grain size analyses performed on a transect of cores from the SE Mediterranean Ridge deformation front facing the Herodotus abyssal plain revealed two additional characteristics:

a) Two different turbidites, named A-turbidites and B-turbidites can be identified on the basis of colour, thickness, and composition. A-turbidites, only a few decimeters thick and often lacking the sand sized fraction, show a clay mineral composition identical to the present Nile derived sediments.

b) The grain size distribution within each B-turbiditic event, investigated through a Fritsch Analysette 20, shows alternation of maxima and minima of the coarsest fraction, with maxima decreasing steadily up-core (Figure 1).

From these observations, we conclude that individual mega-turbidites as they can be described from visual analysis of split cores, are actually composed of several units that can be identified with careful investigation of the grain size. The steady upward decrease of the maximum grain size of the different units suggests that they were produced by sedimentary events of progressively lower energy. Our speculation on the origin of such multiple events suggest that mega-events may occur with the quasi-contemporaneous triggering of several turbid flows in a wide source area. The distal zone of deposition are then reached by the different flows at different times, with highest energy flows first and lowest energy flows last. The upslope increase of the coarsest fraction in each turbiditic unit contrasts with the observation by MUCK and UNDERWOOD (1990) that diluted flows lose less energy than dense flows during an up-slope run because of their higher flow thickness. The genesis of a symmetric or back flow that brings the finest suspended fraction of the flow back to lowest elevations after the flow has reached the maximum elevation is suggested.

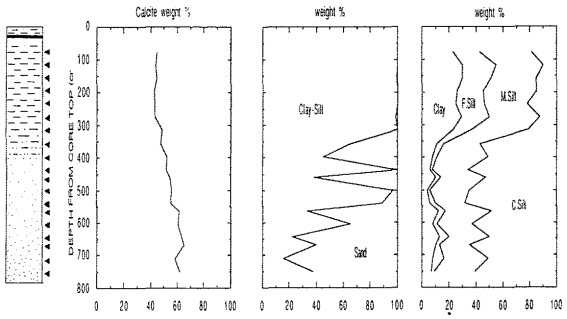

Figure 1 - Lithologic log, calcite profile, and vertical grain size distribution in turbidite 11B from the Herodotus deformation front. Note the alternations in sand distribution within the coarsest base of the turbidite that suggest a composite turbid flow.

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Factors controlling the chemical composition of the Egyptian continental shelf sediments

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The factors controlling the chemical composition of the sediments are the relative proportions of the component minerals of the sea sediments which exert a fundamental control on their chemical composition (RILEY & CHESTER, 1971). Considering the present work for areas under the direct influence of fresh water discharge from the river Nile and drainage waters, it is useful to understand the processes and factors controlling the chemical composition of sediments.

The river Nile is the major source of the metal input in the eastern Mediterranean basin. However, irrigation projects associated with the Aswan High Dam prevent almost completely the discharge of fresh water from the Nile into the sea (SUMMERHAYES *et al.*, 1978).

The present study of the shelf sediments off the Nile Delta between Agami (Alexandria, west) and Arish (east; Fig. 1) is confined to investigate the distribution of the different chemical constituents as well as to define the different factors controlling the chemical composition of the sediments.

A total of 27 surface sediment samples were collected, prepared and subjected for total chemical analysis. The results of the determined major and minor elements [with averages of : Si (20.59%); Al (6.57%); Fe (5.84%); Ca (11.27%); Mg (1.84%); Na (1.36%); K (1.01%); P (0.07%); Ti (0.82%); Ba (0.02%); Sr (0.16%); S (0.29%); Mn (0.09%); Zr (0.02%); V (0.016%); Cr (0.014%); Zn (94.27ppm); Pb (82ppm); Ni (73.8ppm); Cu (40.12ppm) and Co (37.4ppm)] were statistically analyzed. The employed R-mode Factor analysis was used to interpret the interelement associations in the studied shelf sediments. This analysis grouped related elements into a limited number of factors on the basis of their similar behavior. Each factor represents a different geochemical association, possibly caused by mineralogical variations in the sediments. Two Factors were produced (Table 1).

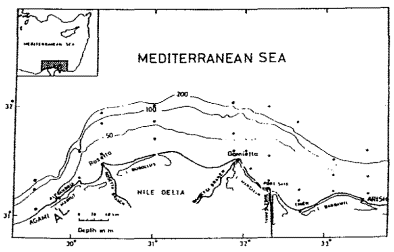
Factor I appears to be a clay factor. It accounts for 76.3 % of the total variance (Eigenvalue = 17.27). It shows a strong association of Al, Fe, Si, Na, K, Mg, Ni, Mn, Ti, Zn and Zr, the elements highly concentrated in clay sediments. Factor II appears to be a carbonate factor. It accounts for 10.6 % of the variance (Eigenvalue = 2.2) and shows an association of Ca, Sr and S, the elements which are highly present in the carbonate sediments.

The mineralogical characteristics of the studied samples reveal that heavy minerals especially opaque, mainly magnetite and ilmenite are particularly abundant at Rosetta mouth, where exploitation visibility studies have been made for ilmenite, zircon, rutile and monazite at Cape Burollus and Damietta sediments gives rise to the high incorporation of elements within the studied sediments. The high association of Fe and trace elements with Factor I is due to the incorporation of Fe with clay minerals. Fe is acting a carrier substance for many trace metals as it fix them largely to the clay (SALOMONS & FORSTNER, 1984).

Table (1): Factor Matrix

Element	Factor I	Factor II
Al	.91088	.44594
Na	.90997	
Fe	.90551	
Si	.90209	
Zn	.86319	.43804
Ni	.86234	.48410
K	.85655	.47533
Pb	.84234	
Mn	.82380	
Co	.81908	.51574
Ti	.79039	.53442
Cr	.77667	.52685
Mg	.77639	
Cu	.77594	
P	.76228	
S		-.93735
Ca		-.90705
V		-.90193
Ba	.47109	.77063
Sr	-.49839	-.76119
Zr	-.64065	.73709

Figure (1): Area of Study



Factor II has high negative loadings for Ca, Sr and S due to the association of these elements with the carbonate sediments covering a limited area to the west of the studied area. Dominant carbonate minerals (aragonite, calcite and Mg-calcite) were found in the carbonate sediments (EL SAMMAK, 1987). The origin of Sr in this area is the product of shell disintegration (EL SAYED, 1985). Ca is closely related to Sr due to the geochemical similarities between them and is highly present in the calcareous test of organisms. S in the sedimentary rocks associates with gypsum and limestone and may be contributed from some skeletons.

The employed factor analysis clarified the factors controlling the elemental composition of the studied area the relationships between mineralogy and geochemistry as well as the interelement associations of the studied elements.

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Mediterranean undercurrent contourites in the Gulf of Cadiz (Spain) : (I) Pliocene-Quaternary seismic facies and bedform patterns

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The seismic stratigraphy of the central region in the Gulf of Cadiz exhibits three major sequences well characterized in both single and multichannel reflection profiles (Fig. 1). The underlying sequence forms the nucleus of linear diapir structures intersecting the slope in a WSW-ENE direction. The intermediate sequence is composed of several units with discontinuous and parallel reflectors, separated by unconformities. These units are largelly attributed to low-energy, terrigenous deposits, which are characterized by the absence of major channels or erosional/depositional features. The youngest sequence is Plio-Quaternary in age and it shows at the base a major erosional unconformity, which is deeply entrenched in the underlying deposits. This sequence is made of contourite facies which formed on the eastern Gulf of Cadiz continental slope. Here the Mediterranean undercurrent has flowed northwestward parallel to the slope contours since the Pliocene opening of the Strait of Gibraltar.

The contourite facies change westward and downstream because of an interaction between the linear diapiric ridges that are perpendicular to the slope contours and the progressive northwest decrease in speeds of the undercurrent. Coincident with the decrease in undercurrent speeds from the Strait of Gibraltar, the following northwestward gradation of contourite seismic facies occurs: (1) sand dune contourite facies on the upstream mid-slope terrace, (2) sediment-drift facies banked against the diapiric ridges, and (3) smooth slope facies with generally continuous, parallel-stratified reflectors (Fig. 2). Downstream, there are several hundred-meter thick sediment drift wedges of sediment drape deposits and high-energy deposits with irregular erosional surfaces and broad-scale, low-angle unconformities.

In the upstream contourite facies, sonar images reveal a wide variation of bedform fields on the present seafloor, caused by variations in undercurrent speeds, as well as by changes in superficial sediment texture. These bedforms range laterally from (a) 2-D, transverse sand dunes in channel floors, to (b) 3-D barchan dunes that laterally evolve to (c) large, straight-crested 2-D dunes, and to (d) 3-D irregularly-shaped dunes, in the silt-covered slope terrace. In contrast, down-valley Mediterranean undercurrent ribbons flowing along the channels between the ridges modify the basic east to west sequence of contourite facies. The down-valley facies exhibit major erosional truncation, and extensive cut and fill facies on seismic profiles (Fig. 1). Sonographs collected across the channelized central sector show (e) erosional scarps, sand patches or rock-outcrops exposed on channel floors; (f) small and parallel 2-D dunes, or (g) regularly shaped, variably size, 3-D dunes along valley walls.

The surface contourite and sediment drift facies on the Gulf of Cadiz slope have formed during the present Holocene high sea-level and full development of the Mediterranean undercurrent. Late Pleistocene hemipelagic-drape facies underlying the Holocene surface sand dune and drift facies correlate with the last lowstand and apparent weak Mediterranean undercurrent development. This Late Quaternary history and the facies stratigraphy observed in reflection profiles suggests that the cyclic Pliocene and Quaternary deposition of contourite and sediment drift, alternating with mud drape facies is related to sea level changes and Mediterranean/Atlantic water circulation patterns.

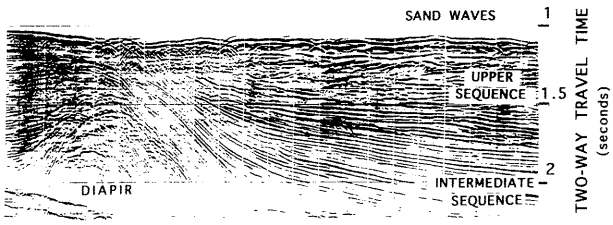

Fig. 1. - High resolution MCS profile from sand wave area showing the three main lithoseismic sequences in the central sector of the Gulf of Cadiz.

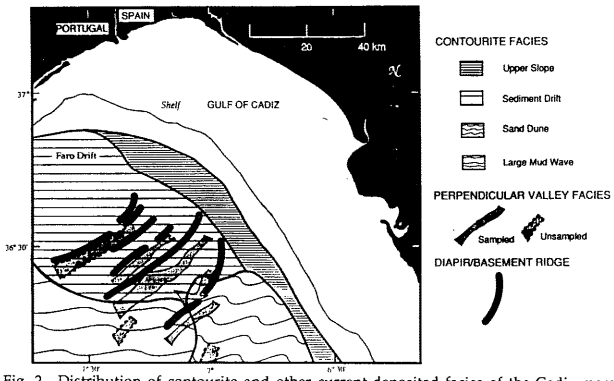

Fig. 2.- Distribution of contourite and other current-deposited facies of the Cadiz margin slope (Modified from NELSON *et al.*, 1992).

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Extensional tectonics along the Dead Sea Rift : the separation of northern Arabia from North Africa?

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The Dead Sea Rift is a 600 km long, 20 km wide geomorphological depression, that shows topographic reliefs of 1,000 to 3,000 m from the axial depression to its mountainous margins in many places. The Rift is the northern extension of the young oceanic spreading center of the Red Sea, and it is built of a series of internal basins, dispersed along the axis of the Rift with 60 - 120 km spacing. The Rift is primarily the product of vertical displacements that downfaulted its floor and uplifted its margins, but some sinistral strike-slip offset affected the Rift as well. The tectonic evolution of the Rift probably started in the Pliocene, subsequent to the termination of the intensive tectonic activity in the Suez Rift in the late Miocene. The transition of the tectonic activity from the Suez Rift to the Dead Sea Rift is due to a probable clockwise jump of the northern edge of the Red Sea spreading center. It is suggested that the morphological and structural similarities between the Suez and the Dead Sea Rifts stem from comparable, though noncontemporaneous, tectonic regimes. The Dead Sea Rift, with its internal basins and its faulted precipituous escarpments, presents an outstanding example of the earliest stages of the evolution of continental break-up and of nascent passive continental margins.

Tectonic interpretation of the voluminous geological and geophysical data from the Rift and its margins is complicated because the information is ambiguous. Part of the data suggests that the Rift is an extensional structure, whereas another part indicates that the Rift is a product of regional sinistral strike-slip faulting. However, it is suggested that the equivocal data are not necessarily conflicting, because the evolution of the Rift is probably associated with resultant displacement of oblique displacement, combining normal and strike-slip faulting. Whereas the interpretation of the oblique offset along the Rift is generally accepted, the quantitative ratio between the extensional and the lateral displacements along the Dead Sea Rift is controversial. There is ground to presume that large downfaulting of the Rift floor and intensive erosion of its uplifted margins obscured and removed critical data that could have provided reliable correlation between the eastern and western flanks. Nevertheless, reconstruction of Triassic, Jurassic and Cretaceous depositional facies zones across the Rift apparently indicates that the lateral displacements along the Rift are approximately 10 km, and various late Tertiary and Quaternary geological features in Syria and Lebanon are in agreement with this interpretation. The amount of displacement by normal faulting is considerably larger than the morphological relief, and seismic reflection profiles suggest vertical offsets that reach 7 km in places. The series of secondary internal basins in the Rift, that seem equivalent to the linear system of axial basins in the northern Red Sea, support the concept that the present Dead Sea is under a tectonic regime that is comparable to the one that affected the Red Sea during the Miocene. These findings are supported by the 25 to 50 percent reduction of crustal thicknesses underneath the Rift. It is suggested that the Dead Sea Rift is an incipient, oblique oceanic spreading center, separating northern Arabia from North Africa.

The Senonian Subsidence of the Levant Basin

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The recently discovered Litani Anticline in the SE Mediterranean basin off northern Israel is buried under a thick sequence of regularly bedded sedimentary series, and suggests a new interpretation of the tectonic regime in the Levant during the late Cretaceous and the early Tertiary. The anticline is approximately 25 km wide, its length is more than 60 km and its crest is uplifted more than 2,000 m. The anticline is buried under series of 5 km of nearly horizontal sedimentary layers, at a water depth of 1,500 m. The apex of the anticline was apparently leveled by erosion. Seismo-stratigraphic correlations with lithological data from boreholes drilled along the continental shelf of Israel suggest that the uppermost folded layer in the Litani Anticline is of late Turonian, and the deepest seismic reflector of the nearly horizontal sequence is attributed to the early Eocene. The patterns of the thickness distribution of the Cretaceous and the Tertiary strata show that pronounced subsidence affected the Levant Basin only since the Senonian. The Turonian age of the uppermost folded layer suggests that the folding of the Litani Anticline occurred during the Senonian, and is contemporaneous with the tectonic development of the folded structures of the "Syrian Arc". The erosion of the apex of the Anticline into an abraded platform suggests further that after the folding, the Anticline was still located in an environment of shallow sea. Only after the erosion did the tectonic block that contains the Litani Anticline subside, and the deposition of the overlying latest Cretaceous - early Tertiary took place in a basinal depositional environment. The Litani Anticline thus indicates abrupt variation of contrasting tectonic regimes along the Levant continental margin of the SW Neo-Tethys Ocean during the late Cretaceous, and fast transition from compressional to extensional tectonic regimes.

Foraminifera of the Alboran Sea : Distribution and Ecology after the last glaciation (18.000-15.000 a B.P.)

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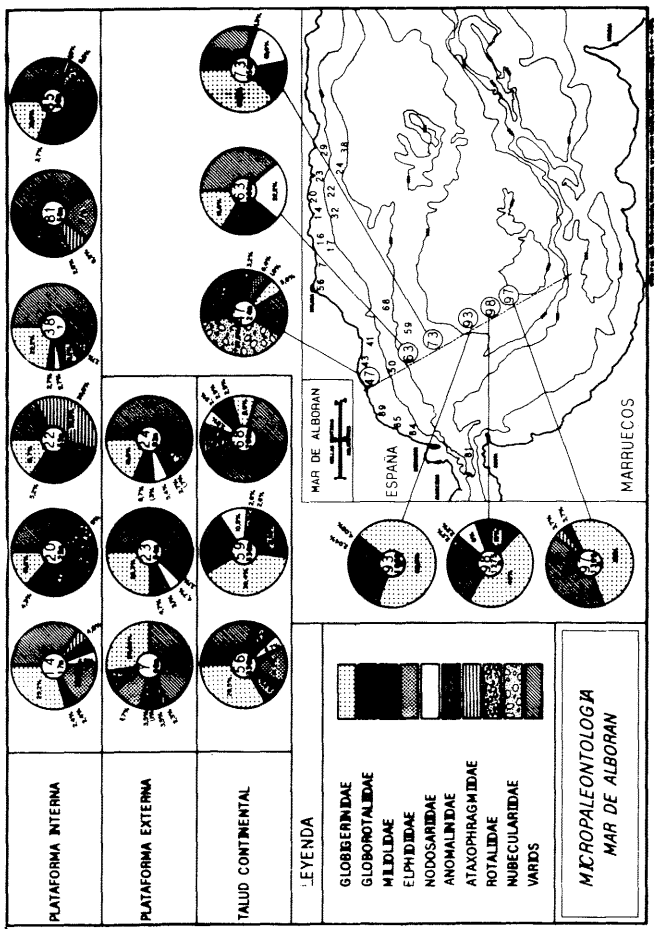
The Alboran Sea is the object of many morphological and geophysical studies which serve as the base for the correct interpretation of its sedimentary biofacies. The biology and taphonomy (transport, disolution, preservation, etc.) of the Foraminifera, necessitates Knowledge of biotopes or productive areas and "post mortem" deposits of the shells. The taxonomical and ecological study of 45 samples obtained between 17 and 1.400 m. of depth, provided us with 360 species and 41 families, which allows us to highlight the following :

1 - The bentonic microfauna is dominated by calcareous-perforates and calcareous-porcelanous formes in the infralittoral and circalittoral zones and agglutinated species in the suprabatial zone. The greatest specific variety in *Miliolidae* (75 sp.), *Discobidae* (27 sp.) and *Cibicididae* (14 sp.) originating from algal and *Posidonia* biotopes, while the *Rotaliidae (Ammonia beccarii)* and *Elphidiidae* of infralittoral zone, through tafocenotic processes, reach deepers areas.

2 - The planktonic microfauna is represented by the post-glcial biocenosis with *Globorotalia* inflata (sinistral form), *Globorotalia truncatulinoides* (dextral form), *Globigerina bulloides* and *Orbulina universa.* Their meso-epipelagic characteristics are in harmony with the present time hydrodynamic model of Gibraltar with the upwelling of Atlantic Water in the northwest of Alboran Sea. The hemipelagitic nature of the suprabatial sediments and the eupelagitic character of the mesobatiales deposits, responds to the planktonic fertility in this area, dating from the Holocene.

3 - The Quaternary glacioeustatisme of Wurm IV (18.000 to 15.000 a B.P.), which 125m coastline regression and with aerial news conditions, in the infralittoral and circalittoal zones forced the emigration of wurmian species (*Cibicides, wellestorfi, Karreriella bradii*, etc.), while the Flandrian transgression (10.000 to 6.000 a B.P.) provided the presents biotopes dominated by calcareous forms whith eurihalines and filoterrigenous species (*Ammonia, Elphidium*, etc.), when the agglutinated microfauna (*Bigenerina, Gaudryina, Textularia*, etc.) conserves its infralittoral and suprabathyal biotopes without glacioeustatic incidence.



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The geological structure of a Peri-Tyrrhenian basin off the gulf of Naples as detected by the MEAS (Multispot Extended Array Sparker)

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The high resolution, single channel seismic reflection profiles presented are a minor part of a marine geophysical survey (about 2,000 km of seismic profiles) (Fig. 1) conducted in 1989 and 1990 in the whole submerged area of the Gulf of Naples (Southern Italy) with the CNR owned R/V *Bannock*. The purpose of the research is the investigation of the shallow geological structure and relationships between volcanism and sedimentation in the Gulf of Naples. During the 1990 campaign we collected a few profiles off the gulf in order to test the capability of the MEAS system in a deep basinal setting where deeper penetration was expected.

The MEAS system, designed by L. MIRABILE, is made by a planar square array of 36"Sparker" type electrodes. The array is related to several accumulators, energizing the electrodes (14-16 kJoules). Energy, accumulated in condensers, is discharged in marine water through the electrodes, producing one vapour bubble for each electrode. Frequency signal of MEAS system is a wide one, having significant energetic contents up to a limit ranging between 500 and 1,000 Hz. Maximum of energy is concentrated around 200 Hz.

Reflections from seaflour and sub-seafloor are picked up by an idrophonic array, tranformed into electric signals and sent to a registration unit. Here they are registered on a VCR magnetic type and on electrosensible paper, after a process of filtering and amplification.

The Gulf of Naples is a peri-Tyrrhenian basin affected by extensional tectonics related to the opening of the Tyrrhenian Sea. The graben like depression which has formed is bordered to the South by the narrow, anti-apenninic trending Sorrentina Peninsula horst and to the North by the Plio-Quaternary volcanic area of Phlaegrean Fields and Procida and Ischia Islands. Consequently, the Gulf of Naples is of particular interest to detect the interaction between the horst and graben structure of the western Apenninic margin and the recent and actual volcanic activity of the area (FUSI *et al*, in press).

The three seismic profiles presented here are located on the confluence between the Napoli Canyon and the Salerno Valley (International Bathymetric Chart of the Mediterranean) or Capri Depression (Carta Geologica d'Italia), a flat floored sedimentary basin at 1000-1200 m water depth. E-W trending profile TIR-1 is located entirely on the sedimentary basin ; NNE-SSW trending profile TIR-2 connects the western edge of the basin to the Ischia volcanic complex; NNW-SSE trending profile ISH-1 connects the eastern edge of the basin to the Ischia volcanic complex across the Banco di Fuori horst.

The deepest penetration recorded is of 1450 ms (TIR-1) (Fig. 2) with the entire reflection free of multiples. This result is of particular interest if it is compared to the average 500 ms penetration obtained in the Gulf of Naples, where multiples of the seafloor also disturb the reflection.

The acoustic basement of the deepest parts of our profiles is interpreted as the Mesozoic carbonates (K horizon of FINETTI and MORELLI, 1974). Near Ischia the acoustic basement is produced instead by volcanic deposits (TIR-2 and ISH-1). A number of acoustic units from the Pleistocene to the Tertiary can thus be identified, including the clastic Messinian facies in the eastern portion of profile TIR-1. The Plio-Quaternary sediments filling up the basin show origin from a delta system identified in the Gulf of Naples and from the volcanic Ischia system.

The structure of the basin is identified by extensional faults producing an overall horst and graben style. Tentatively, a listric fault can be identified on profile TIR-1. The timing of faulting appears as pre- or sin-Messinian in the eastern sector of TIR-1. The deepening of the western sector of the basin, near Ischia, is instead related to the post-Messinian subsidence induced by the growth of the volcanic complex and to the higher volcanic sedimentary input. Of particular interest is the finding of the southern rim of the Ischia volcanic complex 25 km offshore the island (TIR-2).

I summary, the MEAS system has proved to be a powerful and simple tool allowing both high resolution investigation of acoustic units and identification of major geological structures of the Tyrrhenian margin.

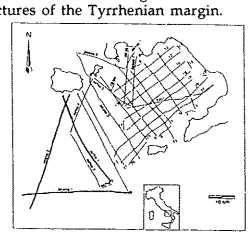

Fig. 1 - Location of seismic profiles

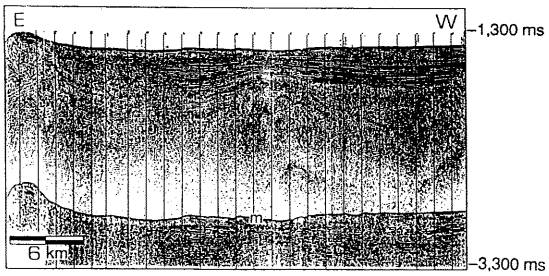

Fig. 2 - Uninterpreted seismic profile TIRR-1. m=multiple

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Implementation of Geographic Information System and Remote Sensing Techniques to Assess the Socio-economic Impact of Sea Level Rise over Alexandria Coastal Region

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Alexandria governorate is located on the western edge of the Nile delta coast. From a geomorphological perspective, it is expected to be less vulnerable to Sea Level Rise (SLR) than the delta proper. However its high population, variable topography and enhanced socioeconomic activities make the impact of accelerated SLR of particular concern. The water front of Alexandria extents for over 42 km from Abu Quir bay to the east to Agami to the west. The city is the most important import/export link between Egypt and Europe.

In order to estimate accurately the impact on the lowlands, Geographic Information System (GIS) and Remote Sensing (RS) analysis have been applied (PARKER, 1988). Data over the governorate of Alexandria were digitized manually for each district and topographic map and fed to a microcomputer (IDRISI version 3.2 software). A Multi-Spectral Scanner (MSS) satellite image has been classified for landuse classes and compared to latest available information on landuse data.

Digitized files were transferred from vector to raster form (HOGG *et al.*,1986 ; VALENZUELA *et. al.*, 1986). Images were then scaled, registered and checked for ground truth observations. A number of control points were used for careful verification. Analysis and interpretation were done using the GIS display for each individual information.

A socioeconomic questionnaire is designed for inhabitants of the lowlands, to measure their awareness and to obtain information on the response, hence a better feeling of the extent of the loss due to SLR could be reached at. The preliminary questionnaire is carried out based on person to person interviews.

An estimate of the impact is obtained based on GIS analysis of the topographic map. It is concluded that all Alexandria beaches are vulnerable to 1m SLR. In addition, three zones are found to lie below sea level : Ameria district lies between 0 and -2m contour, Montaza district lies between 0 and -1m contour, Center district lies between 0 and 1m contour. In addition, lake Mariout lies between -1m and -3m contour levels (Hydraulic pumps are continuously operating to keep the level of water in the lake below 2.8m under sea level, so as to reduce inundation and salt water intrusion caused by rise of lake level).

In order to assess the impact of SLR on industrial and agricultural activities, landuse maps were overlain on topographic maps. It is concluded from the analysis that a large percentage of the area of the governorate lies below the sea level and a population of about 2.0 millions live below the 1m contour elevation. In addition, the agriculture, industrial, and residential sectors are most vulnerable to inundation due to SLR respectively. However, the value of the potential loss in industrial and residential sectors may exceed that of the agriculture sector.

An estimate, based on GIS analysis of population landcover, and landuse is obtained. It shows that the total vulnerable area to 1m SLR is of the order of 1300 km2 and a population of about 2 million people will be directly affected. A population exceeding 8 million people is predicted for Alexandria in the year 2030. Results indicate that, a population of over 4 million will be directly at risk due to SLR in the year 2030 (if no action is taken).

An investigation of the awareness and response of population to SLR over vulnerable area has also been carried out. Preliminary results, based on interviews with 200 random sample of people, indicate that less than 20% of the inhabitants will be willing to move away from the area.

Periodic nourishment and building of some dykes in location vulnerable to saltwater intrusion is believed to be best choice for saving Alexandria beaches and lowlands.

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Quaternary Turbidite Systems in Valencia trough (Western Meditterranean) and lake Baikal (Russia), a key to complex ancient turbidite sequences in Rift basins

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Valencia Trough is an aborted early to mid-Tertiary rift basin, 600 km in length, 150-250 km in width and 1000-2500 m in water depth, which divides the Ebro Iberian continental margin and the Balearic Islands off Spain. Late Pliocene to Pleistocene base-of-slope turbidite systems are developed transverse to the northeast to southwest rift structures on the prograding Ebro margin off the Ebro River delta. In the central Ebro margin, the large subaerial Ebro Canyon was eroded during the Messianian lowstand to 2200 m depth; it later filled with unstable postMessinian marine mud and underwent multiple failures forming chaotic unchanneled turbidite sequences in base-of-slope aprons during Pleistocene sea level lowstands. In the Ebro margin bordering the subaerial canyon, individual canyons and downslope channel-levee complexes of 50 km length generally developed from north to south one after the other with each succeeding sea level lowstand. Ebro channel-levee complexes were drained longitudinally by Valencia Valley in the central trough to form a deep-sea channel that fed Valencia Fan at its distal end. Valencia Fan developed a complete deep-sea fan system, with channel-levee complexes feeding into outer fan lobes, that formed parallel to rift graben structures of the Valencia Trough.

Lake Baikal is the world's deepest (1637 m) and oldest (mid-Tertiary) lake, with a length of 636 km and a width ranging from 30 to 87 km. The lake occupies a tectonically active rift basin and contains syn-rift turbidite system deposits that accumulate in three separate basins. Border faults, with scarp relief that ranges from 1500 to 2800 m, bound the northwest margins of each basin and accommodation zones form ridges that separate the basins. Unchanneled, sand-rich aprons up to several kilometers in diameter have been deposited at the base of the steeply inclined (10 to 45 degrees) border fault scarps and are fed from shoreline fan delta and alluvial fan sand sources. Basin margins adjacent to relatively small rivers or large Pleistocene glacial valleys contain sand-rich, channelized subaqueous fans that range in diameter from 5 to 15 km. In both the central and south basins, the Selenga River feeds larger and finer-grained subaqueous fan systems through faultcontrolled canyons. Numerous fan and apron turbidite systems prograde laterally onto basin floors where axial channels often drain sediment longitudinally.

The lithologic changes in Lake Baikal turbidites from late Pleistocene to Holocene time are similar to those in Valencia Trough marine turbidites. Thick (10-20 cm), medium to fine sand turbidites characterize Pleistocene deposits and these change abruptly to thin (2-5 cm), fine sand to silt turbidites that characterize Holocene deposits. Development of the Valencia Trough turbidite systems results as much from Quaternary climatic changes and increased sediment supply as from sea level lowstands. The changes in Lake Baikal Quaternary turbidite systems appear to be related entirely to effects of climatic change on sediment sources and supply rather than to lake level fluctuations.

There is lateral variation in controlling factors of tectonic setting and sediment supply along rift basin margins in both Valencia Trough and Lake Baikal. This results in synchronous deposition of a wide variety of turbidite systems in different areas of the basin floor. Consequently, the development of base-of- slope aprons, channel-levee complexes, subaqueous fans and axial valleys at different locations along the basin margins cause complicated variation in systems tracts from one basin floor area to another. The turbidite systems in Quaternary rift basins also differ from the general systems-tract models in which ancient turbidite sequences are shown to develop one after the other (e.g. slope fans after basin floor fans). Many Quaternary turbidite systems of rift basins, in contrast, develop coevally as complete growth systems of prograding slope wedges and canyons that continue into subaquous fans, then connect into axial valleys, and finally merge into basin plain sequences.

Neotectonics of the Sea of Marmara basin

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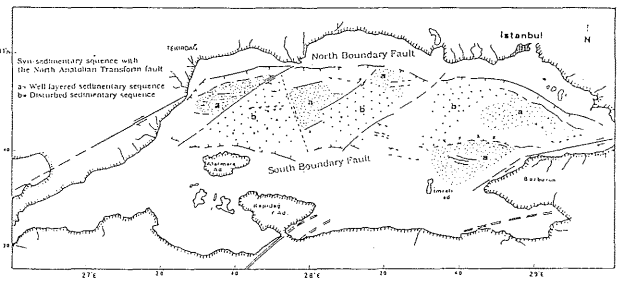
The Sea of Marmara is an inland sea with the areal extension of about 11,350 square km. It is connected with the straits of Bosphorus and Dardanelles to the Black Sea in the north and to the Aegean Sea in the south respectively. It has a very large continental shelf area with many islands. The southern shelf area is much larger than the northern one. There are three deep basins running in the E-W direction. These depressions have the depths : 1112 m in the west ; 1220 m in the middle ; and 1238 m in the east.

The Western Turkey extensional province is the westernmost of three major neotectonic provinces in Turkey that formed following the Arabian/Anatolian collision in the late Serravallian (≈12 Ma) (SENGOR *et al*, 1985). These around the Sea of Marmara (Gulfs of Izmit, Iznik, Gemlik; and Yenisehir-Bursa-Manyas and Saros) lie along the course of N and S strands of the North Anatolian fault, have very strong strike-slip components. The origin of these circum-Marmara grabens is apparently directly associated with the strike-slip tectonics of the North Anatolian fault (BARKA and KADINSKY-CADE, 1988).

Marmara region has different seismic characteristics from the rest of Western Anatolia and appears to act as a separate tectonic unit (CRAMPIN and EVANS, 1986, and EYIDOGAN, 1988). This region shows higher seismic activity than the Western Turkey in general, indicating that this region is partly under the influence of the western end of the North Anatolian fault which splays into a number of branches in and around the Sea of Marmara. Based on fault mechanism solutions, the Marmara block is being rotated and sheared in order to accommodate the right-lateral motion of the North Anatolian fault and extensional tectonics of the Southwestern Turkey province.

The northern side of the Sea of Marmara shows smoother gravity and magnetic anomalies. This area is locally isostatically compensated by an underlying zone of thinned crust with an overall crustal thickness of about 25-30 km. Viewed in their regional context, the magnetic anomalies over the basin, as evidence of recent volcanic activity, are much more likely to be caused by large buried ophiolite bodies, up to several kilometers thick.

The sedimentary sequence in the Sea of Marmara basin is made up of four different formations after the Upper Miocene determined from the single channel airgun seismic data (ÖZEL, 1992). The existance of two basic fault systems is observed: the first one has made up of normal faults at the either sides of the Sea of Marmara basin, extending in the E-W direction; and the secondary system is formed by the NE-SW trending, subvertical strike-slip faults. The E-W trending North Anatolian transform fault changes its direction to west-southwest in the Sea of Marmara, and it is understood that the pure strike-slip motion changes into the wrench fault with extension. The Fault system patterns indicate the surface affects of branches formed by the negative flower structures within the divergent wrench faults.



The map of fault systems and sedimentary distribution
(Fault systems modified from BARKA and KADINSKY-CADE, 1988)

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Danube Delta - Genesis and Evolution

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The Danube Delta can be divided into three major depositional systems: (1) ***the delta plain***, with a total area of about 5,800 sq Km, from which the **marine delta plain** area is of 1,800 sq Km; (2) ***the delta front*** with an area of cca. 1,3000 sq Km, devided into delta front platform (800 sq Km) and **delta front slope** (ca.500 sq Km), extending off-shore to a water depth of 30-40 m; (3) ***the prodelta*** lies off-shore, covering an area of more than 5,500 sq Km. The delta front and especially the prodelta display a pattern of submarine channels, 4-10 m deep, bordered by lateral levees; these channels seem to constitute discharge ways of turbide flow yield by the river distributaries at high flood.

The delta development is controled by the river sediment input (the average sediment discharge is ca. 50 milions t/y, out of which 5-8 milions t/y sandy material); the prevailance of winds from the northern sector (40-50 % of instances); the predominance of southward trending of marine currents; the longshore sediment drift directed also towards the south; the relatively important values of wave power etc. The interaction of these factors is controlling the delta morphological type, the geometry of the volumes of deltaic deposits, the assimetry of the deltas of Danube's distributaries and their development and evolution.

The Danube Delta overlaps the Predobrogean Depression which, in its turn, lies mainly on the Scythian Platform.The sequence of the Scythian Platform cover deposits which constitute the filling material of the Predobrogean Depression display six sedimentation cycles (Paleozoic, Lower Triassic, Middle-Upper Triassic, Jurassic, Lower Cretaceous ans Sarmatian-Pliocene) (PATRUT *et al.*, 1983). The Danube Delta is situated in a aera of high mobility of the Earth crust, repeatedly affected by strong susidences and important sediment accumulations. The deltaic conditions were settled here during the Quaternary, when the Danube started flowing into the Black Sea basin.

The Danube Delta edifice is build up of a sequence of detrital deposits of tens to 300-400 m thick, formed mainly during the upper Pleistocene (Karangatian, Surojskian, Neoeuxinian) and the Holocene. The Holocene evolution of the Danube Delta includes the following main phases : (1) the formation of the Letea-Caraorman Initial Spit, 11, 700-7,500 y.BP; (2) the Sf. Gheorghe I Delta, 9,000-7,200 y.BP; (3) the Sulina Delta, 7,200-2,000 y.BP; (4) the Sf. Gheorghe II Delta and the Chilia Delta, 2,000 y.BP - present; (5) the Cosna-Sinoie Delta, 3,500-1,500 y.BP.

The Danube Delta Plain displays a few facies types of sediments, as follows : (I) marine littoral deposits of two types - type "a", formed by the longshore drift from the North (from the mouths zones of Rivers Dniester, Southern Bug and Dnieper), and type "b", of Danube origin; (II) lacustrian littoral deposits, forming the Stipoc and Rosca-Suez lacustrian spits; (III) fluvial deposits, genetically related to the Danube distributaries, include several types as : bed-load and mouth-bar deposits, subaqueous and subaerial natural levees deposits, crevasse and crevasse-splay deposits, point bar and meander belts deposits, decantation deposits into intradeltaic depressions and interdistributary area etc.; (IV) marsh deposits; (V) loess-like deposits.

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The ecological condition in the N-W part of the Black Sea

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The paper presents the main conclusions of a joint Romanian-Russian geo-ecological survey in the North-Western part of the Black Sea bassin.

The rivers debouching into the NW part of the Black Sea, especially the Danube, are the main pollutant agents in this region of the sea. The river water and sediment discharge is bringing into the sea an abnormaly high amount of microelements and nutrients as a result of drainage of a very large (ca. 817,000 sqKm) and intensively polluted continental area.

The river supply of nutrients is among the main factors contributing to the very strong eutrophication of the sea. The seasonal hypoxia is almost permanently extending on the entire Northern continental shelf of the Black Sea northward the Portita parallel (44 35'N), while anoxia and H2S contamination of the bottom water and sediments are installing in some depressions of this zone (Paleo-Dniestreean Depression, Odessa Depression a.o.), at 25-30 m water depth, where the macrozoobenthos is almost inexistent. Only southward of Portita, on the Southern Romanian continental shelf, the bottom sea water and sediments have a close on normal Oxigen content, and consequently, in this area the macrozoobenthos is almost normaly developed.

In some zones of the continental shelf there became evident an abnormal content of certain microelements as a result of various technogene pollution ; for example, in the Lebada zone Ba, Cu, Zn, Ni from drilling activities, in the Navodari-Constantza nearshore zone - phosphates, V, Cr, resulting from industrial, petrochemical and agrotechnical works, on the Budak Plateau and Odessa Depression - Cr, V, Pb from multiple industrial activities a.s.o.

The entire North-Western continental shelf of the Black Sea is characterised by very high contents of Hg, reflecting a very strong technogene pollution.

The above mentionned results represent a valuable comparison data base for the following phases of a multiannual (1992-2000) and interdisciplinary survey and geo-ecological monitoring of the studied region, which will be carried out within the framework of the "Cooperative Marine Science Programme for the Black Sea" (COMSBLACK).

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Mass Transport processes and their deposition architecture at escarpments of active faults : Examples from the Gulf of Corinth, Greece

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Detailed high resolution seismic surveys using a 3.5kHz O.R.E. and a S.I.G. Sparker system in the eastern end of the Corinth Gulf, in the Aegean back-arc have revealed the formation of an active graben, the "Strava Graben". The Strava graben is an intrabasinal structure, trending E-W and interconnecting the Alkyonidhes and Corinth basins. The purpose of this paper is to reconstruct the principal events and processes responsible for the graben floor fill sequence during the synrift phase.

The Strava Graben is an asymetric graben. It is bordered to the south by a major E-W trending fault whilst to the north it is bordered by discontinuous NW-SE trending antithetic faults. The graben was formed after the submergence of the Alkyonidhes graben and its filling with turbiditic sequences, probably some time after upper Pleistocene. (LEEDER *et al.*, 1991). The wedge shape of the sequence within the graben together with the divergent character of the individual beds are indicative of the continuous activity of the faults bordering the graben.

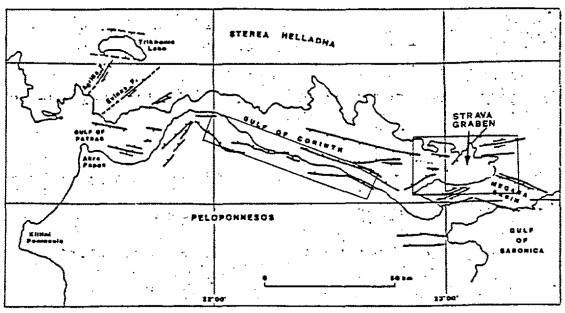
The acoustic character of the deposits in the floor of the graben, together with the spatial distribution of the seismic facies, reveal that gravity driven flows are the only sedimentation process and that the graben floor is exclusively filled by short term catastrophic events.

The emplacement of the individual deposits, which have a thickness ranging from 4 to 10m, in the floor of the graben appears to be a result of liquefied flows. Those flows are derived from the turbiditic sequence resting on the crest of the footwall block bordering the graben to the north. This transport mechanism is inferred by the sheet like appearance of the deposits, the acoustically transparent character indicative of the lack of any internal structure in the deposits, and the absence of non-disintagrative mass wasting deposits either in the source area or in the graben floor.

The liquefied flow deposits are locally seperated by stratified sequences which have a thickness of about 4 m. These sequences consist of thin parallel layers which probably represent turbidites.

Earthquakes which are a common occurence in the Gulf of Corinth can induce liquefaction of the sediments covering the crest of the footwall block bordering the graben to the north and create liquefied or turbidity flows.The mapped pattern of the seismic facies in the graben reveals that the liquefied and turbidity flows have accumulated as aggradational stacks consisting of sheet like lobes forming base of slope aprons that are fed by multiple sediment sources along active faults.

The findings of this study together with the results of the offshore studies in the Alkyonidhes bay by PERISSORATIS *et al.*, (1991) and LEEDER *et al.*, (1991)in the surrounding land area suggest that the tectono-sedimentary development of the present day active Strava graben is comparable to the Viking, Moray Firth and Witch Ground grabens in the North Sea.



General structural map of the Patras-Corinth and Megara rift zone. The location of the Strava graben is also shown.

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Gas charged sediments in the Aegean and Ionian Seas

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The Aegean and Ionian seas are parts of the Hellenic Arc-Trench system which is located within one of the world's most seismically active zones (MC KENZIE, 1972) and has experienced extreme tectonism through Tertiary and Quaternary times. Normal planar and listric faults which have been active since Pliocene are responsible for the formation of shallow and deep basins (Corinth and Patras gulfs, Trichonis lake, Amvrakikos gulf, Sporades basin) with high rates of uplift and subsidence and resulting high rates of erosion and deposition.

During the last ten years seismic surveys in various environments in the Aegean and Ionian seas revealed anomalous acoustic characters (acoustic turbid zones, gas pockets, gas plumes, enhanced reflectors, columnar disturbances, wipe outs) and meso to micro morphological features (pockmarks, domes mud volcanoes, elongated depressions) which were attributed to the presence of gas in sediment interstices (FERENTINOS, 1991). They usually occur in water depths less than 250 m. The gas charged sediments are found in (i) Pleistocene and present-day deltaic environments (ii) Pleistocene and present-day fjord-like environments (iii) lakes (iv) open sea environments.

Pleistocene and present-day deltaic deposits (foresets and bottomsets) in Amvrakikos gulf, Patras gulf and NW Aegean shelf are gas charged as is suggested by the acoustic turbidity, the enhanced reflectors, the gas plumes and mid-water reflections in 3,5 KHz profiles. Slides affecting these deposits and underlain gases suggest a cause-and-effect relationship. No pockmarks are found in these environments.

The Quaternary sedimentary cover of the Amvrakikos and Patras gulfs which represent present-day and Pleistocene fjord-like environments, respectively contains gas which is very often in the form of gas pockets and gas plumes and produce intrasedimentary and seabed small relief doming. Gas plumes migrating along active fault planes or seeping through the seabed to the water column were observed on the seismic records. Seabed displacements due to faulting are sometimes associated with depressions which follow the trace of the faults for some distance. According to HOVLAND (1984) we assumed that they are elongated depressions caused by the violent escape of gas via fault planes. In Amvrakikos gulf buried pockmarks (paleopockmarks) were identified in 3,5 KHz profiles.

Open sea environments where gas has been detected in the sediments are the NW shelf of the Aegean sea and the NE shelf of the Ionian sea (Corfu island). In the NW Aegean shelf the gas is found in Plio-Quaternary grabens and near fault planes. In the NW Ionian shelf the gas is associated with salt domes.

Gas has also been found in Trichonis take as it is indicated by the acoustic turbidity which appears in the sediments all over the lake.

Since big rivers and streams discharge into the aforementioned environments the gas is expected to be of biogenic origin. Only in the NW Ionian shelf and in the NW Aegean shelf where gas is found in association with salt domes and appears to migrate from deep horizons respectively, it is believed to be of thermogenic origin.

Grain size analysis of samples taken from all these environments reveals that although the seafloor is favourable for formation of pockmarks, their occurence in seismic records was very scarce. This may be due to the high seismicity which characterise these regions. The internal pressures are expanded by the cyclic loading of the seismic waves destabilizing the granular framework and thus cause the gas to release.

A rather unique acoustic character which has not been previously described in the literature was recognised in seismic profiles in Corfu shelf, Trichonis lake and Amvrakikos and Patras gulfs. Coarse-grained beds in parallel lying sedimentary sequences, giving rise to strong echo returns, sometimes seem to be laterally interrupted and producing intermittent reflectors with a permanent rhomboid shape for some distance. Because this acoustic character is found in relation with gas charged sediments it may be possible that upward migration of small amounts of gases disrupt the texture of the sediments and contemporary acoustic phenomena contribute for this acoustic response.

Vertically migrated gases around diapirs or faults may found porous horizons, and be expulsed producing coherent reflections of increased intensity or acoustic turbidity over short distances around these structures. Thus, is concluded that not only vertical seepage but also lateral migration of gases in permeable beds can create enhanced reflectors in seismic records.

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G

Présentation des cartes morpho-bathymétriques de la Méditerranée nord-occidentale levées à l'aide des sondeurs multifaisceaux Seabeam et Simrad EM 12 DUAL

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*Station de Géologie Marine "la Darse", VILLEFRANCHE-SUR-MER **(France)**

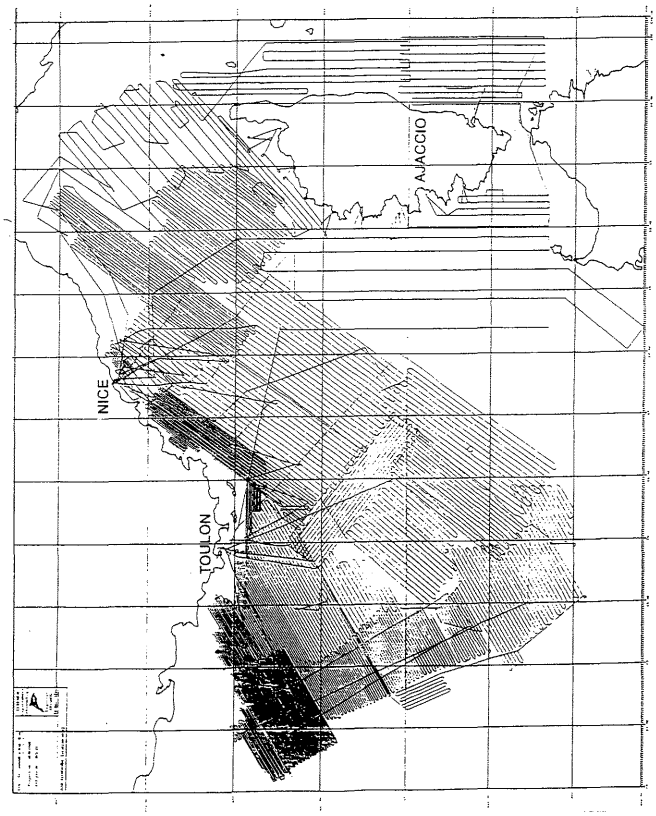
Au cours des dix dernières années, des levés systématiques ont été effectués sur la façade maritime méditerranéenne française, à l'aide de sondeurs multifaisceaux installés sur les N.O. Jean Charcot et l'Atalante.

Le sondeur Seabeam a permis la cartographie de la majeure partie de cette zone au cours de plusieurs campagnes successives; la largeur du couloir insonifié est de 0,7 fois la profondeur. Avec le système Simrad EM 12 DUAL la largeur du couloir est de 7 fois la profondeur dans notre zone de travail, d'où un gain de temps considérable (cf. carte jointe: la zone autour de la Corse a été cartographiée avec le nouveau système Simrad).

Ce programme de cartographie a été effectué à des fins scientifiques et dans le cadre d'un programme national de cartographie, d'exploration et d'inventaire des ressources dans les zones maritimes nationales.

La carte jointe montre toutes les routes des navires engagés dans cette étude et qui ont servi de base à la réalisation des cartes morpho-bathymétriques. La précision de navigation est du type GPS. Les levés et les cartes de base sont réalisés à l'échelle du 1/50 000. Une centaine de cartes au 1/50 000 ont été établies et sont archivées dans la banque de données du programme ZEE à IFREMER/Brest. La zone totale est également représentée à l'échelle du 1/250 000 en 3 coupures, et en une carte à l'échelle du 1/500 000.

Le poster présentera la carte des navigations et la carte à l'échelle du 1/500 000 avec plusieurs "loupes" à l'échelle du 1/50 000 de régions représentatives: canyons, hauts-fonds, dômes de sel...



G

The Romanian Shoreline Response to Erosion Factors

Iulian POSTOLACHE

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The paper presents the erosion factor action on the Romanian shore. The coastal balance, erosion rates and storm effects are analysed.

Comparison of the beach profiles shows that the coastline retreated about 180-300 m between 1962-1991, in the northern sector (Sulina - Vadu). The beach surface lost about 2200 hectares, that is 77 hectares/yr but the acumulation amounted only 169 hectares, that is 6 hectares/yr. Some details are given in the figure 1.

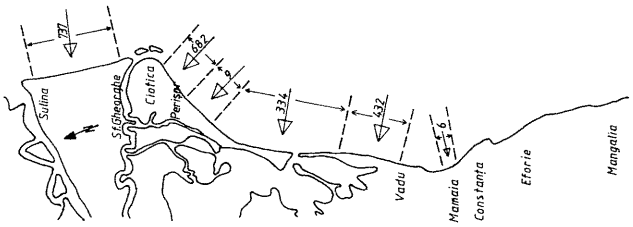

Fig. 1 The Romanian littoral - the eroded surfaces (hectares)

Between the dynamic forces, wind and solid material there is a fragil equilibrium which determines the Romanian littoral to be an open system. Its instability is obvious when there is a moderate agitation but specially under stormy weather. These conditions determine the erosion to propagate in time. Thus, even if a period without storms follows moderate waves continue to erode the shore with great values. There were situations when shore erosion rates were equal with the retreat of the coastline under storm weather. This is explained by the new environment conditions in which the dynamic factors action : a new shoreline position, steeper submarine profiles and an poorer sediment stock. The above mentioned instability is very important when there are many storms in a year.

Annual average rates are not so much in relation with other zones from other littorals, but they are very important for the Black Sea coast where the tide is negligible.

Some zones are continuously eroded. This evolution shows the future consequences. For a few portions this evolution caused a complete erosion of the beach. Some examples are in figures 2. Hydrotechnical constructions and artificial nourishment were necessary to stop the erosion and the destruction of the touristic buildings.

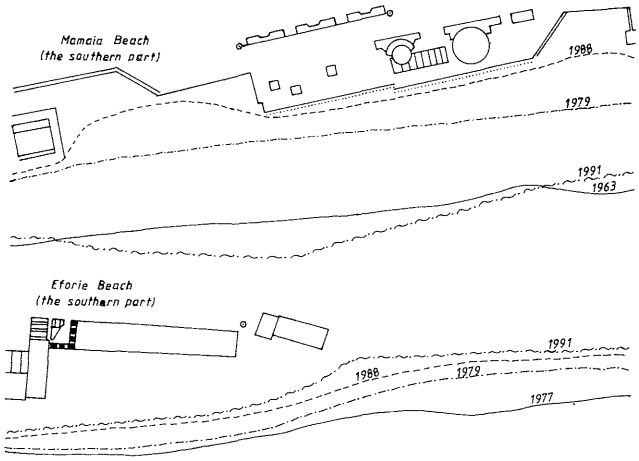

Fig. 2 The coastline evolution

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Sub-Recent to modern sediment facies in Manzala lagoon, Nile Delta, Egypt : natural versus man influenced factors

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The four major lagoons on the northern Nile Delta of Egypt are undergoing rapid and dramatic modification by both natural and anthropogenic factors. In order to establish a baseline database for monitoring the evolution of Manzala lagoon in the northeastern delta, a campaign of topographic measurement of the water-table of lagoon and a program of surficial sediment sampling (90 grabs and 30 short-cores) across the entire lagoon was initiated in 1990 in close collaboration between the Smithsonian Institution of Washington D.C., Ain Shams University of Cairo and University of Catania.

The surface of the lagoon (about 450 sq. Km) was reduced by 20 % between 1973 and 1987, and by 11.7 % between 1987 and 1990. If the evolution of the lagoon continues at this rate, the surface areas of Manzala will be further reduced by 1/3 by the year 2000.

Surficial samples were recovered from all environments in the Manzala lagoon, from depths of 0 to almost 1.5 m Short-cores were selected fairly evenly from the different areas of lagoon, in the southwestern area influenced by the drains coming from Nile river; in the southeastern one influenced by canals join the lagoon and in the northern area influenced by sea water).

Statistical analyses take into account grain size (% clay, silt, fine sand an coarse sand fraction) along with composition of sand fraction (identification of 300 or more grains per sample). Sand components include mineral (light and heavy mineral, mica, glauconite/verdine, pyrite, gypsum), faunal (forams, ostracods and molluscs) and floral (diatom and plant fragments).

Statistical analyses indicate the degree of relation among the various textural, mineralogical, faunal and floral variables. Four distinct and regionally specific facies are recognized on the basis of cluster analysis in the surficial environments, and another facies, absent in the modern ones, was identified in the recent samples.

The modern facies are: Proximal sandy marine, is present in the northwest lagoon area; it shows well sorted sediments very rich in light mineral (influenced by wind).

Linear silty clay lagoon, is lies just landward the sand ridges; it seems a central lagoon sediment "polluted" by the previous eolian sediments.

Silty sand (center lagoon), is the most prevalent facies in Manzala lagoon and is divided into three sub-facies: Sub-facies A: in the southern margin of the lagoon, influenced by Nile water; Sub-facies B: in the easthern-central area. The central lagoon sediment s.s.: silty and rich in light, heavy minerals and brackish shells (euryhaline); Sub-facies C: the less well-defined subfacies A and B, it is present near the center of the lagoon and southeast of El-Mataria influenced by drains. Silt, near islands and inlet, is geographically restricted to areas protected by islands and/or bays in the southern part of the lagoon.

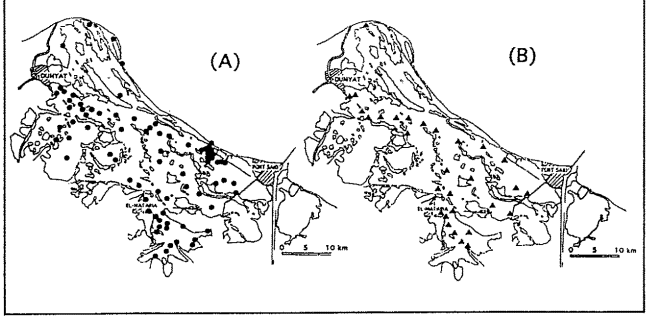
A new facies was identified in the recent sediments: Clayey silt sediments, present in the southeastern area; that area is progressively smaller than 60 to 20 years ago; actually, it is disappearing.

Facies can be related to natural processes such as coastal sand ridges which separate the lagoon from the sea. Other facies and the rapid evolution of the surface of the lagoon are more closely related to man's impact, and include land reclamation and dredging in the Port Said and El-Mataria region, and pollution via several large drains entering the southern margin of Manzala lagoon.

For the last two reasons, we believe that the recent facies close to El-Mataria disappeared.

The statistical method applied in this investigation is now being used for study of the other modern Nile delta lagoons (Idku and Maryut), and also to interpret ancient (late Quaternary) lagoon deposits recovered in subsurface Nile Delta core sections.

Location of surficial samples (A) and mini cores (B) in Manzala lagoon, NE Nile Delta, Egypt



Sediments dynamics investigation in off-shore zone of Israel southern sea coast by means of luminescent tracers

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2. Open University of Israel, TEL-AVIV (**Israel**)

Investigations are based on the field experiments with luminescent tracers (LT) using. Sand grains were treated by anthracene dissolved in chloroform with resulting appearance of bright blue luminescence under UV lamp excitation. With the aim of high sensitivity of LT detection on the background of untreated sand luminescence, the optimal parameters of LT excitation and luminescence were determined by means of excitation-emission spectroscopy. As may be seen, the best excitation wavelenght is at 350 nm and luminescence detection interval is 450-480 nm.

In the upstream measuring section sand taken from the same area and treated by luminophor have been placed on the bed by injection. In the downstream section ground samples have been taken at certain intervals. The luminescent analysis was made by the two following ways. Firstly, the standard quantity of the ground was examined using fluorescence microscope and the LT were detected and selected. The tracer concentration in a sample was determined as a ratio of the separated part weight to the total weight of the sample. Secondly, the luminescence intensity of different samples were determined by luminescence spectrometer under constant conditions. The tracer concentrations were defined by comparison with artificially prepared samples with fixed quantitites of LT. All results were treated by personal computer and corresponding statistical parameters were determined.

According to LT dispersion, sediments stream along the shore is calculated and submarine canyon (Ashkelon district) influence on its transit is determined. Comparative assesments of sediments interceptions by canyons are accomplished between Israel's sea coast and Black sea coast. Dependence between sediment stream characteristics and wind wake is proposed. Influence of hydrotechnical industrial enterprises on the sediments balance in the inshore zone is demonstrated.

G

Les rejets de "Phosphogypse" dans le Golfe de Gabès et leur impact sur l'environnement marin

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Situé dans la partie méridionale de la Tunisie orientale, le Golfe de Gabès est caractérisé par un plateau continental très étendu, à très faible pente et soumis à un climat aride.

A l'issue des observations et des différentes analyses, il s'est avéré que l'essentiel du remplissage sédimentaire du Golfe de Gabès est carbonaté, constitué par des débris bioclastiques, sans toutefois négliger l'arrivée d'une fraction terrigène par la voie éolienne ou à la faveur des crues exceptionnelles.

Sur le plan granulométrique, hormis les faciès sablo-vaseux ou vaso-sableux, on a distingué l'individualisation de deux vasières ; la première est dans la partie septentrionale du golfe en face de la Skhira et la deuxième dans la partie méridionale en face de Zaraat.

La mise en place des différents faciès sédimentaires est liée aux courants de marée et surtout aux courants de houles provoqués par les vents d'Est et Nord-est qui sont dominants dans la région. Les courbes cumulatives semi-logarithmiques sont du type parabolique manifestant le caractère instable des sédiments du golfe. Ce caractère permet d'avancer que le secteur d'étude est une zone de haute énergie. Ce fort hydrodynamisme va favoriser non seulement le brassage des sédiments mais aussi une remobilisation presque permanente des dépôts superficiels surtout que le substrat du golfe est dépourvu de tout couvert végétal.

Le Golfe de Gabès sert de réceptacle aux rejets du complexe d'industries chimiques implantées depuis une vingtaine d'années autour du port de commerce de Ghannouche situé à trois kilomètres au nord de Gabès.

Les différentes usines, après attaque du minerai de phosphates par l'acide sulfurique, produisent de l'acide phosphorique et des engrais phosphatés (Triple Super Phosphate) accompagné par la genèse d'énormes quantités de «phosphogypse» déversées en mer. Ces déchets seraient à l'origine d'une agression très prononcée sur l'équilibre de l'écosystème. Ces rejets, représentés essentiellement par une phase solide qui est le «phosphogypse», constituent un flux de matière relativement très élevé de l'ordre de 5.10^6 tonnes par an. Néanmoins, en se basant sur la diffractométrie aux rayons X cette matière minérale, supposée depuis longtemps répandue dans la majeure partie du golfe, n'a pu être reconnue qu'à proximité des sources d'évacuation à une distance ne dépassant pas quelques kilomètres.

Vu le fort hydrodynamisme régissant le golfe et en tenant compte de la solubilité relativement élevé du gypse dans l'eau de mer, il semblerait qu'on assiste à une dissolution quasi totale du «phosphogypse» rejeté. D'ailleurs, la non préservation de cette matière minérale dans le bassin récepteur a été bien mise en évidence par les faibles teneurs en ions sulfate $SO_3^{=}$ révélées par l'analyse chimique du sédiment brut. Ces teneurs en $SO_3^{=}$ sont comprises entre 0,5 et 1,6 %; les taux les plus élevés restent cantonnés dans la partie occidentale du golfe directement soumise aux déversements de «phosphogypse».

Afin de pouvoir suivre l'évolution des rejets industriels, certains éléments chimiques qu'ils renferment tels que le fluor, le zinc et le cadmium etc... ont été considérés comme des marqueurs de pollution.

La distribution superficielle des différents traceurs a permis de délimiter des zones à degrés de contamination différents, mais le secteur le plus affecté se situe dans la partie méridionale suivant une bande littorale d'une quarantaine de kilomètres allant de Ghannouche à Zaraat.

Le littoral de Jerba ainsi que le secteur sud-est du golfe, en face du canal Ajim, se trouvent épargné de l'impact des rejets industriels de Ghannouche. Il semble que cette zone soit le siège d'un important courant qui constitue vraisemblablement une barrière naturelle contre la propagation des éléments polluants issus du complexe chimique.

L'analyse du cadmium dans les sédiments de carottes a permis de préciser la puissance de la tranche sédimentaire contaminée dans le Golfe ; celle-ci accuse des valeurs relativement élevées pouvant excéder une cinquantaine de centimètres, notamment dans le secteur où les dépôts superficiels dénotent une forte influence des rejets industriels. L'importance de la tranche sédimentaire contaminée serait la conséquence d'un concours de différents paramètres qui caractérisent actuellement le Golfe de Gabès tels que : l'énorme quantité de «phosphogypse» évacuée en mer, le fort hydrodynamisme, l'absence d'un couvert végétal, la nature et la texture des sédiments du fond etc....

G

Mediterranean Deltas and global change : Method to distinguish Tectonic subsidence and compaction from climatically - induced sea level variations

Daniel Jean STANLEY

Mediterranean Basin Program, Smithsonian Inst., WASHINGTON (**USA**)

The deltas of the Mediterranean, whether of large (Nile, Rhône, Po), moderate (Ebro, Ceyhan) or small size (more than 100 are known), and regardless of geographic/geologic setting, are characterized by low-lying coastal plains. The configuration of these delta plains is increasingly affected by man's intensified activities, including industrial and municipal waste, channelization and reduction of water flow (and, usually in consequence, sediment load) to the coast, and irrigation, agricultural and aquacultural projects. Effects of man-induced activities are in some cases quite serious, as exemplified by the Nile Delta of Egypt which is being markedly modified by a very rapidly increasing population density.

A substantial part of most lower delta plains lies within 1 m elevation above mean sea level. As would be expected, these low-lying environments, including wetlands, so vital for growing agricultural and aquacultural needs, are extremely sensitive to changes in position of delta plain surfaces relative to sea level. Ongoing multinational research at the Smithsonian Institution in Washington, D.C. is focusing on methods to more finely calibrate the nature and rates of delta land subsidence, eustatic sea level change, and their combined effects on delta margins.

It is of note that the modern Mediterranean deltas began to form at some time between 8000 and 7000 years B.P. (Fig. 1), and these dates correspond closely to those of deltas in other regions, including the Mississippi. This specific time period probably signals the initial phase of deceleration of rising sea level, when delta accumulation and progradation, rather than erosion, began to prevail along the world's coastlines.

Our method to distinguish sea level rise from subsidence involves radiocarbon dating of carefully interpreted deltaic facies in deep continuous borings recovered across delta plains. Particularly useful are peats and organic-rich (marsh and lagoon) layers which accumulated within about 50 cm from sea level. These dated horizons (Fig. 1) serve as distinct markers, and the depth of these strata in borings is compared to a series of eustatic sea level curves defined on the basis of a survey of such curves in different world oceans (numerous publications in the literature). We find that, almost inevitably, the age of these peaty facies which underlie outer delta plains occur at depths considerably greater than is indicated from the eustatic curves. Thus, if one subtracts the depth expected from an averaged sea level stand for a specific time period from the actual depth of recovery in the boring below mean sea level, one can obtain the amount of lowering (by compaction or isostatic depression, or both) since the time of deposition of a specific layer. This method indicates rates of subsidence in the northern Nile Delta ranging from 0.1 to 0.5 mm per year (Fig. 2).

Projected rates of sea level rise resulting from global climate change remain a source of contention. Regardless of such eustatic projections, our results indicate that the seaward margins of Mediterranean deltas are experiencing subsidence. This fact, coupled with the reduction of sediments carried by some of the principal rivers, is resulting in erosion leading to wetland loss. An equally serious consideration is the landward progression of saline groundwater and decreased agricultural productivity. In view of the serious consequences, an international effort is being initiated at the Smithsonian to monitor the evolution of different delta margins in the Mediterranean.

Examples of subsidence affecting the northern Nile delta of Egypt *(modified after D.J. Stanley, 1990. "Recent subsidence and northeast tilting of the Nile delta, Egypt." Marine Geology, 94:147-154)*

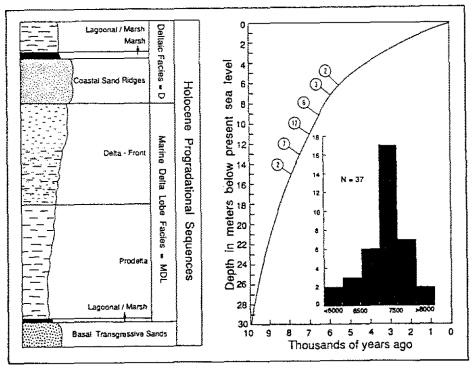

Fig. 1. Left: Generalized Holocene sequence on lithostratigraphic log showing MDL and D facies above basal transgressive sands. Right: Age of the base of the Holocene mud sequence above the transgressive sands. Histogram shows range of dates in yrs B.P., and these data are plotted on the eustatic sea level curve after Lighty et al. (1982).

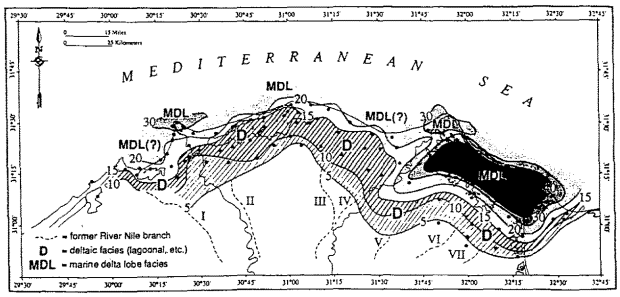

Fig. 2. Isopach map showing sediment thickness of mid-Holocene to present age lying above basal transgressive sands. D and MDL denote sediment facies depicted in Fig. 2. Contours in meters. Traces of former River Nile branches (after Toussoun, 1922, and Said, 1981): I=Canopic; II=Saitic; III=Sebennitic; IV=Bucolic; V=Mendesian; VI=Tanitic; VII=Pelusiac.

Nile Delta, Egypt : Effects of sea level, climate, tectonic subsidence and man

D.J. STANLEY and Nile Delta Project Team,

Mediterranean Basin Program, U.S. NMNH, Smithsonian Inst., WASHINGTON, DC (**USA**)

The Nile delta, Egypt, is the focus of an international and multi-disciplinary (petrography, faunal and floral analyses, geochemistry, neotectonics, archaeology) investigation, initiated at the Smithsonian Institution in 1985. This major long-term program involves 25 specialists in 13 organizations in North America, Egypt, and Europe. Of specific interest are models of the paleogeographic evolution of this large depocenter through time. The study considers the interplay of major natural and anthropogenic factors controlling sedimentation on the basis of extensive petrological, geochemical and biogenic analyses of more than 2500 samples in nearly 100 cores. This investigation, evaluating the past 30,000 years of Nile delta evolution, enables us to define facies development during a near-complete cycle of high-low-high sealevel stands. Most borings (length to 60 m) are radiocarbon dated, and it is of special interest to archaeologists that the delta, as we know it today, began to form about 7500-7000 years ago.

The northern delta plain has been subsiding (from 0.04 to 0.50 cm/yr), and also has tilted seaward toward the northeast during this period. Sediments have accumulated at long-term averaged rates of 0.1 to 0.5 cm/year, from West to East. Marked variations in temporal and lateral lithofacies distributions and sequence thicknesses are, in part, a direct consequence of asymmetric structural lowering of the delta plain surface during the period of rapid sediment accumulation. In addition to (1) neotectonics and (2) eustatic sealevel rise (about 15 m during the past 7500 years), other factors have affected deposition: (3) a change from humid (starting about 12,500 years ago) to arid (about 5000-4000 years ago) climate which altered sediment input to the delta from East African and Ethiopian source areas and increased the development of sebkhas, and (4) strong easterly-directed longshore currents that have eroded sectors of the coast and developed extensive coastal sand ridges and dunes. Classic deltaic coarsening-upward sediment sequences consisting of open marine prodelta to coastal facies are restricted to the northeastern delta; this is largely a response to accelerated subsidence in this region. In contrast, sediment sections are reduced in thickness and comprise lithologically more irregular successions of delta plain deposits (distributary channel, marsh, lagoon) over most of the tectonically more stable north-central and northwestern sectors of the delta.

Both natural factors, such as the burial of the delta plain by rapid sedimentation and submergence resulting from tectonic subsidence and encroachment of the sea, and man's activities, such as reclamation of lagoons for agricultural purposes, are rapidly changing the configuration of the Nile delta. Our database suggests that the sea will encroach landward by as much as 30 km on the northeastern delta plain by the year 2100. Ongoing research is focusing on loss of lagoons, expansion of coastal dunes and pollution. These three aspects, plus the landward migration of saline groundwater, are of serious concern in view of Egypt's rapidly increasing population, now believed to be 55 million and increasing at a rate of 1 million every nine months.

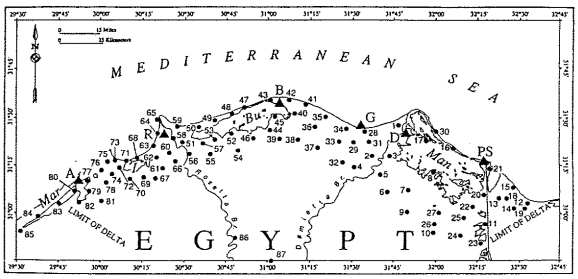

Fig. 1. Map of the northern Nile Delta, Egypt, showing the four modern lagoons: Man=Manzala; Bu=Burullus; I=Idku; and Mar=Maryut. Dots denote the position of 87 long cores collected during 5 expeditions (1985-1990). Cities and towns include : PS=Port-Said, at the northern end of the Suez Canal; D=Damietta, along the Damietta branch of the Nile; B=Baltim resort, at northeastern end of Burullus lagoon; R=Rosetta, just south of the Rosetta Promontory of the Nile; and A=Alexandria, along the northern margin of Maryut lagoon. Short cores and surficial samples will be collected in Maryut and Burullus lagoons in spring 1992, and in Burullus and Manzala lagoons in 1993.

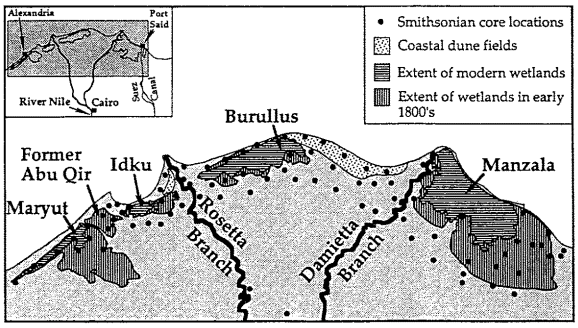

Fig. 2. Map showing the approximate extent of lagoon and associated marsh loss (> 50%) since the early 1800s of the four modern lagoons and the disappearance of Abu Qir lagoon. Also noted are the extensive coastal sand dune fields that have buried former large lagoons in the region between Burullus and Manzala lagoons during the past 2900 years (modified after STANLEY, WARNE *et al.*, 1992).

Contribution à l'étude des Deltas des types Rhone et de leur régime hydrogeologique. Etude comparative des deltas du Nestos et du Mornos (Greece)

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Les conditions de formation du dellta du Nestos (Grèce du Nord) (1), (2) et de celui du Mornos (Grèce centrale) (3) sont exprimées à la fois par des caractères communs et des caractères différents. A partir de ces identités ou différences et de leur analyse, nous avons essayé de contribuer à l'étude des deltas de type Rhône, selon la classification proposée (4), dont la formation est surtout influencée par le régime fluviatile (apports détritiques) et l'action de la houle, l'action de la marée étant insignifiante.

Les deux deltas reçoivent les apports détritiques des bassins versants des fleuves et des massifs de bordures dont le réseau hydrographique est dirigé vers le delta sans transiter par le fleuve. Ils reçoivent aussi un certain volume d'apports détritiques provenant des bassins voisins par des fenêtres hydrologiques. Les fleuves sont aménagés tant dans la plaine deltaïque (digues), que dans leurs cours amont (barrages). Tout ceci modifie la distribution granulométrique des sédiments transportés, dont la propagation est influencée par l'existence des élévations du socle mésozoique dans le domaine marin en face des deltas. La différence essentielle entre les deux deltas concerne leur superficie (Nestos 400 km2, Mornos 25 km2). Cet "effet d'échelle" entraîne quelques particularités pour chaque delta, mais, les apports détritiques du Mornos ne sont pas inférieurs aux apports du Nestos. Ceci est vérifié par la pente du talus du delta, qui est brusquement incliné par une suite d'une tectonique de failles normales successives. Cette tectonique provoque des glissements sous-marins qui déforment et éliminent les accumulations détritiques au niveau du prodelta.

Les apports détritiques énormes du Mornos ont fait que ce petit delta présente une isohypse maximale de la proéminence deltaique de 15 m, tandis que celle du grand delta du Nestos n'est que de 12 m. Les indices quantitatifs du régime des apports détritiques sont exprimés par les valeurs de l'"intégrale hypsométrique sous-marine" - IH, qui exprime, entre autres, la relation entre le volume des matériaux apportés et la capacité de la houle à les distribuer (5). Le traitement des données figure au tableau 1. Les valeurs plus élevées que 0,50 (convexité) correspondent à des apports détritiques volumineux tels, que l'action de la houle ne peut pas les distribuer entièrement. Pour le delta du Nestos, cette analyse coincide avec les cartes bathymétriques et avec les résultats des forages exécutés dans le delta. Pour le delta du Mornos, sans orientation privilégiée des lits du fleuve, l'analyse morphométrique laisserait prévoir également une convexité, alors que l'analyse morphométrique laisserait prévoir une concavité du talus sous-marin et du prodelta, qui est en fait confirmée par les cartes bathymétriques. Cette divergence est due à la forte pente originelle du talus et aux glissements successifs, donc la concavité est d'origine sécondaire (épigénique). Les caractères communs aux deux deltas et la nature sécondaire de la concavité du delta du Mornos peuvent être mis en évidence à l'aide de l'index "B", indice de distribution des sédiments dans la proéminence deltaique (5). Les valeurs de "B" figurent au tableau 1.

La destruction continue du delta du Mornos est le facteur principal à l'origine des faibles valeurs de B, concernant ce delta. Si l'on ne tenait pas compte de cette particularité, on pourrait conclure que ces valeurs résultent d'un "effet d'échelle", alors que ce sont des valeurs non représentatives. L'orientation principale des apports détritiques et l'effet fictif d'échelle sont prouvés par la forme des côtes des deux deltas. Pour le delta du Nestos, les côtes occidentales sont caractérisées par un système de barrières typiques. Sur les côtes centrales, on ne trouve qu'une grande barrière, tandis que, sur les côtes orientales, il n'y a pas de barrière. Pour le delta du Mornos, quelques traces d'une tendance à la formation de barrières sur les côtes occidentales pourraient être liées à l'aménagement du fleuve dans cette région.

Delta	IH			B		
	occ.	centr.	orients	occ.	orient	B
Nestos	0,72 (conv.)	0,61 (conc.)	0,37 (conc.)	0,380	0,300	0,340
Mornos	0,95 (conv.)	—	0,75 (conv.)	0,095	0,070	0,083

Les résultats obtenus par l'IH confirment les résultats provenant de l'apparition des barrières. Pour le delta du Nestos, la convexité concerne les côtes occidentales et centrales, tandis que la concavité de la partie est indique l'absence des lits actuels principaux du fleuve, dans cette région, au moins pour le stade final de l'évolution du delta. Pour le delta du Mornos, la dominance absolue de la convexité indique l'absence d'orientations privilégiées des lits du fleuve dans le delta. Par contre, elle indique une diffusion des sédiments dans la plaine deltaique et le long des côtes. La concavité sécondaire de ce delta est épigénique come on l'a vu plus haut. On aboutit aux mêmes résultats en considérant les valeurs de l'index "B" (indice de distribution des sédiments dans le domaine de la proéminence deltaique). Pour le delta du Nestos la valeur de B, concernant les côtes orientales est plus élevée que celles concernant les côtes orientales. Ceci indique l'orientation des sédiments surtout vers l'Ouest et la liaison de cette orientation avec les formes des nappes aquifères est, alors, évidente. En ce qui concerne les nappes aquifères, leur forme est directement liée à la localisation des lits au cours de l'évolution du delta et à leur communication. Ce schéma a été vérifié par les forages d'eau. Ces forages fournissent les données lithologiques qui soulignent le résultat essentiel de cette étude comparative. Les deltas de type Rhône maintiennent leurs caractères sédimentologiques initiaux, malgré la différence à l'échelle et malgré les évènements épigéniques qui modifient leur configuration superficielle.

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Thermodynamics of formation and stability of Northupite in the Tuzla salt deposit in Bosnia and Herzegovina

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The Tuzla salt deposit in the central part of northern Bosnia and Herzegovina (Yugoslavia) is a Miocene age salt- dome deposit, whose geological origin is still not fully clear with respect to its marine or non-marine formation (i.e. whether the halite is marine or recycled from dissolution of the rock-salt diapir). The principal saline minerals of the evaporite deposit are halite, anhydrite and thenardite. The mineral assemblage also contains accessory minerals such as northupite, nahcolite, glauberite, probertite, teepleite and bradleyite. Among these, northupite is particularly interesting with regard to its origin and formation and has previously been studied for its trace element content (KNIEWALD *et al.* 1986).

Northupite, $Na_2CO_3.MgCO_3.NaCl$ or $Na_3Mg(CO_3)_2Cl$ is a rare mineral, and apart from Tuzla - which now is a classic occurence of northupite - is found only in a few other places in the world. Earlier researchers proposed chemical schemes for its formation involving diagenetic alteration, while more recent studies showed that direct precipitation from brine solutions is also a feasible pathway of formation (VANCINA *et al.* 1986). Although northupite is usually regarded as a typical lacustrine mineral, it can through diagenetic processes be incorporated into marine or mixing-zone sequences. In the Tuzla evaporite deposit northupite occurs in several textural types, ranging from megascopic octahedral crystals in a marl matrix to millimetre-sized brownish crystals (coated with organic matter) imbedded in halite. The Fe(II) enriched ferronorthupite is closely associated with iron sulphides indicating its formation in reducing environments or diagenetic alteration.

Using the equilibrium computer code SOLMINEQ.88 (KHARAKA *et al.* 1988) and the chemical composition of a recent brine percolating through sections of the halite strata (table 1.), the mineral-solution equilibria for northupite formation and dissolution were established. Since the database of SOLMINEQ.88 or other available codes contain no thermochemical values for northupite, its chemical potential was taken as $\mu°RT^{-1} = 989.6$ (FELMY and WEARE, 1986). The thermodynamic solubility product of northupite was taken as $\log K = -4.8 \pm 0.3$ at 25 deg C (VANCINA *et al.*, 1986).

Table 1. Chemical composition of a recent brine in the Tuzla evaporite deposit (density 1.207 gcm^{-3}, concentrations in g/L)

NaCl	Ca	Mg	Cl	SO_4	HCO_3	H_2S
269.3	11.0	4.24	193.2	0.6	2.93	0.0013

The calculated saturation state of the brine, derived from the normalized saturation index, implies that northupite precipitation is thermodynamically feasible. If ancient seawater should on the basis of present day major constituent composition be regarded as undersaturated with respect to northupite, the formation environment can be interpreted in terms of the mixing-zone model.

An inherent problem which has to be considered in geochemical equilibrium modelling of saline mineral assemblages lies in the fact that an entirely non-marine brine can also produce mineral sequences characteristic of modern seawater, since they may contain an identical final invariant salt assemblage. Therefore, in the absence of indicative trace constituent data, the variations between predicted vs. observed mineral sequences associated with the Tuzla northupite may be credited to :

a) departure of the present day brine from ancient brine/seawater composition, and/or
b) diagenetic alteration of the original marine mineral assemblage.

A final implication of the performed solubility calculations using the SOLMINEQ.88 code is that the comparatively widespread occurence of northupite in the Tuzla deposit is the result of magnesium carbonate mineral suppression. This would have caused large substantial amount of Mg ions to remain in the brine facilitating northupite formation.

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Sedimentary processes in the Petit Rhone Canyon and the Rhone upper fan inferred from Sar profiles

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As part of the "Processus sédimentaires sur les pentes et Instabilités" research project of IFREMER, a geophysical survey using the SAR french side-scan sonar (Système Acoustique Remorqué), the multibeam echosounder EM-12 and a SIG 600 KJ sparker, was carried out in January 1992, in the Gulf of Lions (South of France)(Fig. A-B). The goals of the survey were to characterize, by their seismic and side scan sonar signatures, the instability processes of a young passive continental margin and to study their relation with the high frequency cycles of sea level changes. The studied area includes the shelf break, the slope and the upper domain of the Rhône deep sea fan.

The morphology and architecture of the Rhône deep sea fan has already been described from sea-beam and superficial seismic data by BELLAICHE *et all.*, (1983), DROZ (1983) and DROZ and BELLAICHE (1985). These authors differentiated the continental slope located between the shelf break (-180 m) and the isobath -1600 m and the upper fan located between 1350-1600 to 2000 m depth (Fig. C), with a main valley and associated sedimentary levees. On the slope, the Petit Rhône canyon is considered as the main vector for sedimentary supply towards the deep sea fan and then considered mainly as an erosional domain . The study of new SAR profiles across the Petit Rhône canyon, on the slope, and across the main valley of the upper fan shows that the sedimentary processes that occur in the area are not so simple.

The Petit Rhône canyon has a U section 3.5 km wide and 250 m deep on the upper slope (SR 50 profile, fig. D. 1), and becomes narrower and shallower downslope (see TR 24 profile, fig. D.2). A unit characterized by discontinuous high amplitude reflections overlains a basal unconformity. As displayed on the TR 24 profile this unit is thicker on each side of the Petit Rhône canyon.

These deposits demonstrate the existence of depositional processes in a domain previously considered as an erosional domain.

The TR 7 and TR 36 profiles (Figs. D.3, D.4), across the upper fan domain show the main valley with a flat bottom and an inner minor V valley shaped, few hundred metres wide and 70 m deep forming like terrace features. The main valley is infilled by the unit characterized by discontinuous high amplitude reflections (with interbeded transparent zones) which onlap the basal unconformity. On the TR 7 profile, this unit is confined in the main valley, whereas downwards (by exemple on the TR 36 profile) it also constitutes the eastern border of the main valley. Despite the absence of cores permetting us the datation of the upper unit and the basal unconformity, we suppose that the upper unit on the slope and the upper fan domain must be contemporaneous.

The formation of a basal unconformity in the canyon and the main valley might result from sea level fluctuations, whereas the presence of the upper unit on both sides of the Petit Rhône canyon and infilling of the main valley remains puzzling. In the main valley, it could be the result of (1) infilling of the main channel with slumps and channel facies as suggested by the presence of interbedded transparent facies followed latter by the incision of the minor valley, or (2) overflow deposition from the minor valley, as suggest by KTR7 and KTR8 cores obtained during the TRANSRHO survey which show a succession of fine turbidites which are interpreted as typical levee facies, or even a combination of these two mechanisms.

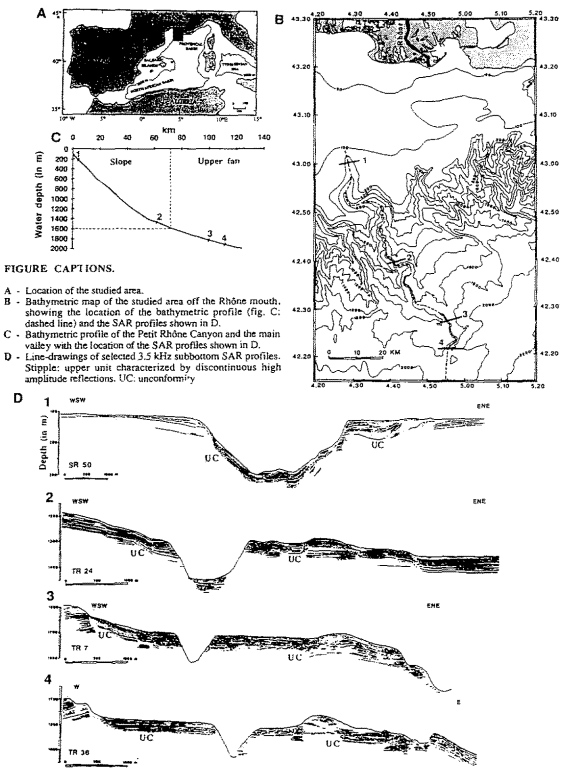

FIGURE CAPTIONS.

A - Location of the studied area.
B - Bathymetric map of the studied area off the Rhône mouth, showing the location of the bathymetric profile (fig. C: dashed line) and the SAR profiles shown in D.
C - Bathymetric profile of the Petit Rhône Canyon and the main valley with the location of the SAR profiles shown in D.
D - Line-drawings of selected 3.5 kHz subbottom SAR profiles. Stipple: upper unit characterized by discontinuous high amplitude reflections. UC: unconformity

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Strike-slip tectonics in the Puglia Shelf between Gargano Promontory and Monopoli (Southern Adriatic Sea)

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The Puglia shelf represents the prosecution of the foreland of the Apennine Chain (the Apulian Platform) which is affected by several normal-slip faults lowering it off shore (MOSTARDINI and MERLINI, 1986).

The faults characterizing the studied area constitute both mainly NW-SE trending systems, parallel to sub parallel to the coast, and rather straight-lined, roughly E-W trending ones. Some of the faults were activated as normal-slip faults since Jurassic (DE'DOMINICIS and MAZZOLDI, 1989) and caused a lateral differentiation of sedimentary environments. In correspondence with some of them, also during the Cretaceous, carbonate platform and basin facies were separated.

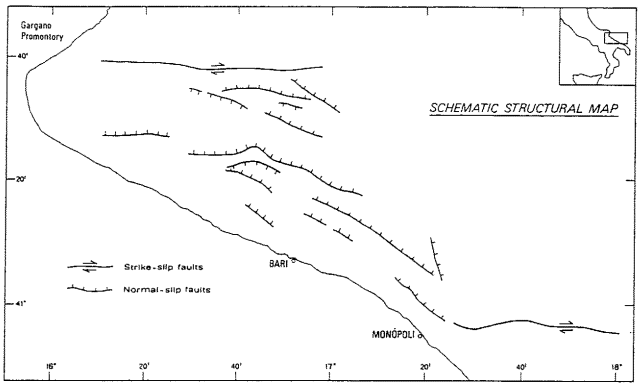
Flexotir and Air Gun seismic profiles interpretation allowed us to recognize an evolution in terms of strike-slip tectonics of the E-W trending systems located South of Gargano Promontory and East of Monopoli.

The South-Garganic system represents a right-hand shear zone whose main structural feature is the right-hand strike-slip fault pointed out by FINETTI (1982) (Gondola Line in DE'DOMINICIS and MAZZOLDI, 1989), which should extend as far as the mainland where it continues in the tectonic alignment S. Giovanni Rotondo-Monte S. Angelo. Cross sections of this structural element, which has been active at least till the base of the Plio-Quaternary sequence, show positive and negative flower structures (COLANTONI *et al.*, 1990).

The system East of Monopoli is located approximately in correspondence with the 41st parallel, and it is characterized by a set of high angle often anastomosing faults, bounding a series of basins and structural highs now buried by Plio-Quaternary deposits. The braided pattern of faults and especially the rhomb-shape of some basins allow us to relate such system to a right-hand shear zone. The presence of basins and structural highs results from divergence and convergence of the anastomosing right-hand strike-slip faults within the shear zone (CROWELL, 1974). The faults acted till Lower Pliocene; they do not seem to extend as far as the mainland but they end westwards in correspondence with normal-slip faults parallel to the coast.

The two systems represent deep regionally important features connected to the counterclockwise rotations of the Adriatic Plate or "African Promontory" already pointed out by FINETTI (1984), LOWRIE (1986), ANDERSON (1987).

The strike-slip tectonics took place during the Tertiary both reactivating the Jurassic normal-slip faults responsible of the first fragmentation of the Apulian Platform, and determining the formation of new strike-slip faults. Most of the parallel to the coast NW-SE trending normal-slip faults should be considered produced by the along-strike stepover on the right-slip zones or, in some cases, they may represent subsidiary structures across strike-slip faults with differing amounts of horizontal displacement.



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Late-Quaternary transgressive erosion and deposition in the Adriatic epicontinental Basin

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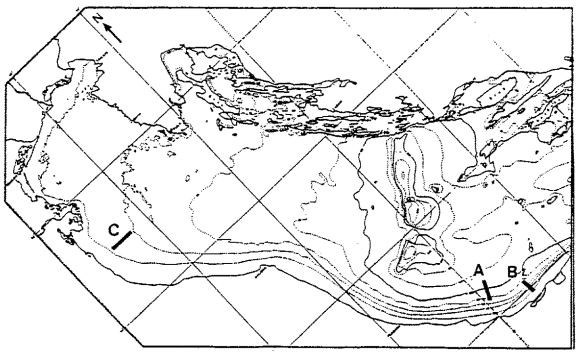
The study of modern continental margins provides several examples of transgressive erosion and deposition that originated during a short time span of increasing accommodation, and/or decreasing sediment supply, driven by the post-18-ky eustatic rise of sealevel. When detectable on seismic profiles the TST is defined as a succession of backstepping or retrogradational parasequences ; it rests on a transgressive surface marking the first major flood of the previous LST. The top of the TST is the surface of maximum flooding above which the parasequence stacking pattern is progradational. Low sediment supply and/or extensive erosional processes during relative sealevel rise can determine the lack of deposition or preservation of the TST. High-resolution reflection seismic profiles document the variability of thickness, internal organization and position in time of the transgressive systems tract that originated during the post-18-ky relative sea level rise within two distinct portions of the Adriatic epicontinental basin.

The Adriatic sea is an elongated and narrow (800 X 200 km) epicontinental basin consisting of a wide and gentle shelf to the north, the Mesoadriatic Depression, below a 140 m deep shelf-break, and a more complex ramp area to the south (Fig. 1). The shelf area located south of the Mesoadriatic Depression corresponds to the Apulian foreland ramp. During the late-Quaternary relative sealevel fall and lowstand a prograding wedge resulted from a process of "forced regression" and is capped by a transgressive erosional surface. A stack of onlapping (backstepping) marine wedges lying above the Transgressive surface is observed in areas where high sediment input counteracts the late stages of relative sealevel rise. In this case the Transgressive surface is markedly erosional with a plurimetric relief likely shaped by shoreface retreat as well as marine processes. No indication of paralic deposits is observed within the TST in this case ; as a consequence, the ravinement surface coincides with the transgressive surface (Fig. 2A). In areas of higher sediment supply, washover deposits can be preserved ; they downlap onto backbarrier deposits that show an aggradational backstepping configuration (Fig. 2B). Above the backbarrier transgressive deposits, a thin wedge or drape of shelf sediment can be detected; it belongs to the TST and is floored by the Ravinement surface and capped by the maximum flooding surface.

Fig. 1: Schematic bathymetric map of the Adriatic epicontinental basin.



The northern Adriatic area encompasses the Apennine foredeep and foreland basin filled by Plio-Quaternary progradational deposits with no evidence of aggradation . During the late-Quaternary lowstand this area underwent extensive subaerial erosion followed by the deposition of a lowstand wedge on the northern edge of the Mesoadriatic Depression. Seismic correlation proves that progradation from the north (fed by the Po river and tributaries) encompassed the early stages of relative sealevel rise (likely before R inflection point) while the southern area was experiencing erosional retreat and ensuing flooding of the shelf. Transgressive deposition in the Northern area is dominated by barrier island complexes and delta front bars (Fig. 2C). Tidal inlets and fluvial distributary channels appear as shallow (typically a few metres deep) erosional features that extend on short distances; they differ thus from the deeper and more continuous fluvial systems, entrenched during relative sealevel fall and lowstand, that are preserved in outer-shelf areas. Deposits appear sandier compared to the manne transgressive parasequences observed in the southern area. The Ravinement surface can be distinguished from the transgressive surface (TS) at the base of the TST, but is coincident with the maximum flooding surface (MF), because of the lack of detectable marine transgressive deposits, and, at places, with the sea floor, because of the lack of highstand deposition.

When imaged by means of high-resolution reflection seismic profiling, using broad-band sound sources, the stratigraphic record of the late-Quaternary transgressive deposits of the Adriatic epicontinental basin appears punctuated by several closely-spaced flooding surfaces that separate parasequences (i.e.: relatively conformable shoaling upward succession of genetically-related beds). Sediment supply, oceanographic setting and regional gradient control whether the facies that characterize the transgressive deposits are dominantly paralic. dominantly marine or both.

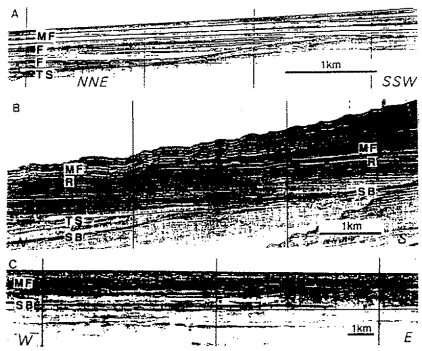


Fig. 2 : Examples of late-Quaternary transgressive deposits in the Adriatic epicontinental basin. A : Backstepping parasequences consisting of marine deposits bounded by flooding surfaces (F). Note coincidence of Transgressive surface and Ravinement surface (TS). MF is maximum flooding surface.
B : Land-ward dipping washover deposits downlapping onto backbarrier transgressive facies. Note the thin wedge of shelf transgressive deposit between the Ravinement surface (R) and the maximum flooding surface (MF). TS : transgressive surface; SB : sequence boundary. C: Transgressive parasequences underneath the HSST prodelta wedge; note the shallow distributary channels in delta-front deposits.

Geophysical studies in the Gulf of Edremit

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Approximately 500 line-kilometers of single-channel continuous seismic reflection and magnetic profiles were obtained with 40 cu-in PAR airgun system and proton magnetometer in the Gulf of Edremit (Western Turkiye). The data were collected from the research vessel K. Piri Reis of the Institute of Marine Sciences and Technology (Izmir-Turkiye). Fig. 1 shows the schematic tectonic map of the western Turkiye and surroundings.

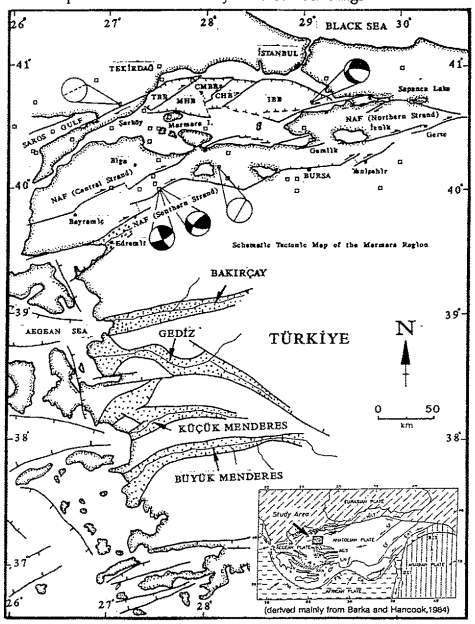

Fig. 1: Schematic tectonic map of Marmara region and western Turkiye derived from WONG *et al*, 1990 and AKSU *et al*,1990.

Detailed interpretations of the geophysical data show that the Gulf of Edremit is also an asymmetric graben as well other east-west trending grabens in the western Turkiye, associated with the regional north-south extension of the Aegean plate. These grabens and the intervening horsts control the west flowing drainage systems of western Turkiye.

Fig. 2 shows the geological map of Gulf of Edremit area and the seismic lines were measured during the cruise and offshore exploration well Edremit-1. The interpretation of seismic data shows that there are several NE-SW trending faults in the Gulf of Edremit which are subparallel to the major "southern strand of North Anatolian Fault (NAF)". The activities of these faults began probably in early Miocene and are still continuing.

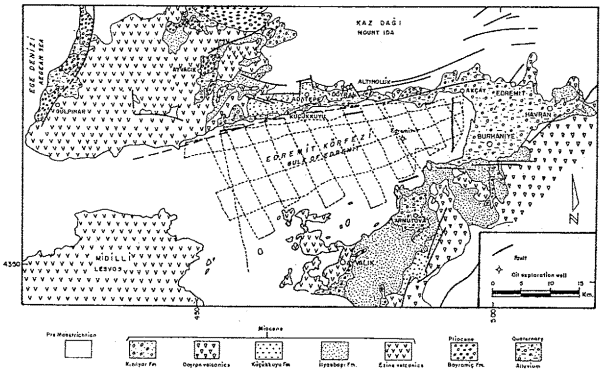

Fig. 2 : Geological map of Gulf of Edremit area (from SIYAKO *et al*, 1989) and seismic and magnetic lines.

From the magnetic data is shown that there are no important anamolies in the northern side of Gulf of Edremit. But in the southern side of region there are some important anamolies, because of the volcanic rocks which appear on land and on islands.

There was also further obtained gravity data from the Gulf of Edremit besides obtained seismic and magnetic measurements. Calculated gravity models from Bouguer Map of north western Turkiye show that there are 2-3 km thick sediments in the Gulf of Edremit which are transported by the streams of "Edremit Çayl", "Havran Çayl" and "Karadere". The sediments in the eastern side are thicker than the western side in the Gulf of Edremit.

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Mudvolcanoes in the Black Sea

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During 1991 an international group of scientists and students carried out a training and research program on board the Russian Research Vessel "*Gelendzhik*". In the Russian sector of the Black Sea this was partially directed towards a study of the distribution and character of mudvolcanoes in an area South East of the Crimean peninsula, by means of subbotom profiling and side scan sonar recording, followed by box- and gravity coring.

In the study area the upper two seconds of the sedimentary sequence consist of Plio/Quaternary sediments with well stratified, parallel to sub parallel reflectors which locally are interrupted by the piercing and diapirism of the mudvolcanoes.

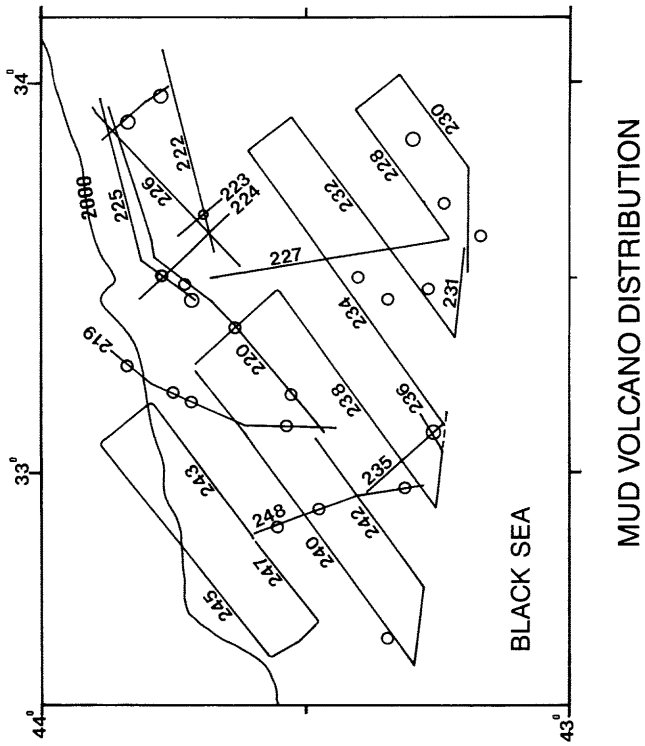
The mudvolcanoes generally have a mushroom shaped or volcanic crater like cone that rises 40-120 m out of the surrounding, flat seafloor. Their diameter at the seabottom ranges from 900-2700 m. However, a number of mudvolcanoes has an asymmetrical shape, with a depressional sink and with rims along the margins.

Numerous diapiric structures were also observed at greater depth below the seafloor, sometimes associated with growth faults extending from their tops towards the surface, and with faulted or folded reflectors above and on top. Aside from positive features in the sedimentary column, collapse structures at depth can al so be observed, and are relatively abundant.

Side scan sonar records show the presence of smaller scale vents and seeps and locally show the presence of mudflows, carrying blocky lumps of semiconsolidated material over the rims.

Most probably the bright spots observed at 440-600 ms TWT below the seafloor represent the presence of gas; earlier results from MSU indicate the presence of methane and gas hydrates in and near the zone where mud volcanoes are abundant.

Fig. 1 Shows the shallow seismic reflection and (partially) sidescan sonar recording lines (indicated by nrs) of Black Sea cruise R.V. "*Gelendzhik*" 1992 in the area south east of the Crimean peninsula. Circles give positions of (expected) mudvolcanoes.



New magnetic maps and the Tectonic implications of the Eastern Mediterranean

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All magnetic data available for the eastern Mediterranean Sea, Black Sea and Turkey were reevaluated and reprocessed into new magnetic maps.

The total data set available for the studied area was collected over a period of 22 years. Having taken the secular variation of the earth's magnetic field into consideration, we used the revised IGRF (International Geomagnetic Reference Field) i.e. DGRF (Definitive Geomagnetic Reference Field) to calculate a series of magnetic reference fields which were reduced from the observed total magnetic intensity data respectively. Errors of some data sources were also corrected during the reprocessing.

The onshore aeromagnetic data in Turkey were measured with a mean terrain clearence of 2 000 ft. The offshore data were upward continued to a level of 3 000 m so that it is possible to compair and interpret both data sets.

The total magnetic anomalies achieved as described above were reduced to the geomagnetic pole. In general, the magnetic anomalies shift with respect to the magnetic sources when they are observed away from the geomagnetic pole. The pole-reduced magnetic anomalies show clear correlation with the crustal structures.

Both the non-pole-reduced and pole-reduced anomalies were interpolated for the maps with a grid of 6 km x 6 km. The new magnetic maps show NW-SE positive trends which are parallel in the eastern Mediterranean Sea, in the Black Sea and in the Turkey. They are probably the indication of the active zone of the lithosphere. The bending zone of the positive anomalies near the Cyprian and Hellenic arcs may be related to the boundary of the Africa plate and Eurasia plate.

The results of the qualitative and quantitative analysis of the magnetic anomalies will be presented and the implications for the tectonic features in the studied area will be discussed.

The Anaximander mountains : linking the Hellenic and Cyprus Arcs

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[3]International participants aboard the R/V *Gelendzhik* for the 1991 Training Through Research cruise in the eastern Mediterranean and Black Seas

The Anaximander Mountains lie at the northeast and northwest ends respectively of the Hellenic Arc and the Cyprus Arc, in the region where the two arcs intersect each other. The Mediterranean Ridge extends southwest from the mountains and the Florence Rise is continuous to the southeast. To the north, the Lycian Promontory of southwestern Turkey projects southwards toward the Anaximander Mountains.

The depths of three peaks identifiable on the International Bathymetric Chart of the Mediterranean (IBCM) are, from west to east, 1022 m, 973 m, and 927 m. A fourth peak with a depth of 1155 m was observed by us further to the east. Deeper water surrounding the mountains varies from over 4000m in the Rhodes Basin to the west to about 2500 m in the Antalya Basin to the east.

The 10 day 1991 geophysical and geological survey addressed the problem of the nature and development of the mountains. Transpressive motion along the southeastern Hellenic Arc is expected from the relative movement of the Aegean microplate with respect to the African plate; and compressive motion is expected along the southwestern boundary between the Turkish microplate and Africa, in analogy to the southwestern margin of the Aegean microplate. Dissimilarities between both arcs (e.g. compared to the Cyprus arc, the Hellenic arc has higher seismicity, active vulcanism in the Aegean backarc, a thick acretionary sedimentary prism south of Crete, and a trench system) suggest interesting geological and deformational differences. Using over 2100 km of seismic profiles, long-range sidescan sonar data (OKEAN), gravity and magnetic measurements, and bottom samples we examined the structure, trends, and deformational fabric to determine the neotectonics, with the hope of identifying influences of both arcs in the evolution of the mountains.

At first glance the Anaximander Mountains appear to have more affinity to the Florence Rise because they lie on two regional swells extending along the rise to the southeast. Furthermore there is a narrow seafloor valley separating them from the Mediterranean Ridge. On the other hand, the southernmost peak of the mountains is roughly linear and aligned with the Mediterranean Ridge trends, along with a northeast-southwest fault zone lying immediately to the southeast of it. There appears also from the gravity data to be a major structural difference between the southwestern and northeastern peaks. The Bouguer anomaly (density 2.67 g-cm^{-3}) is as high as 190 mGal over the southern peak and drops to 40 mGal along the northeastern boundary between the Anaximander Mountains and the Antalya Basin. A strong gradient of about 3 mGal-km^{-1} separates the southwestern two peaks of the mountains from the northeastern two, and coincides with structural and tectonic divisions. There appear to be more variations in the magnetic anomaly (-30 to +200 nT) east of this dividing line than to the west.

The relative gravity high disrupts a low which follows the Mediterranean Ridge (centred on the Strabo Trench) and the Florence Rise. The fact that it also coincides with topographic highs indicates under-compensation and suggests that the topography may still be in the process of being pushed up. Later compensation would result both in the mountains sinking back on a down-flexing lithosphere and an associated reduction in the gravity high. The regional low over the Mediterranean Ridge results from a thick accretionary prism of sediments lying on the depressed lithosphere of the African plate dipping into the Hellenic Arc subduction system.

All the Anaximander Mountains appear to be fault-bounded along their steep sides. All appear to be composed of sedimentary rocks which have been folded and thrusted (generally southward although they all tilt in different directions). The basement sedimentary strata have very strong reflections compared to the overlying sedimentary strata; and they are thought to be pre-Miocene, and probably older than Messinian as the characteristic seismic signature of the Late Miocene is not observed (i.e. neither the Messinian evaporites nor the rough-looking erosional surface). A fragment of Early to Middle Eocene nummulitic limestone was retrieved along with other rock fragments from one gravity core on the steep fault scarp of the southern peak. One preliminary working hypothesis is that the rocks are from a southern extension of the Lycian promontory of southern Turkey, in which case they might be continuous with the Bey Daglari and the Lycian or Antalya nappes.

The western mountain is a north-tilted (at about 2° to 4°) sedimentary basin of about 30 km long. The basin was probably tilted as a large unit as there is almost no internal deformation. The upper sediments are about 600 ms thick (TWTT, two-way travel time) on average but are locally as thick as 1400 ms TWTT. These sediments are continous with flatlying sediments in the Fineke Basin to the north. The whole unit appears to be sliding down to the northeast beneath a thick pile of off-scraped sediments which shows no coherent internal reflections in the seismic profiles.

Virtually none of the upper sediments seen on the west mountain are present on the southernmost mountain. This mountain is crescent shaped because it is a northwestward dipping syncline with a steep southeast face exposing the edges of the folded strata. The dip of the strata to the northwest is about 21°. They curve westwards towards the south and can be observed cutting obliquely across the narrow valley separating the mountains from the Mediterranean Ridge. The distinctive seafloor pattern made by the truncated strata of the northward dipping folds in this area indicate that the folding effects strata over a wide region south of the peaks and west towards the Rhodes Basin. There are also indications of karstic topography in the region of low relief south of the mountains and along the Florence Rise.

The easternmost of the mountains resembles the western one insofar as it is a tilted block of sediments, but its northeastward dip is more in keeping with the expected compressional axis across the Florence Rise. Tight folding (with northwest-southeast fold axis) in the Antalya Basin sediments immediately to the northeast of the rise also testifies to the compression. These structures are roughly parallel to and coincident with the gravity low. The northernmost mountain lies on the same broad swell with the same trend as the Florence Rise. The morphology of this mountain is more rugged and varied than that of the other mountains.

It seems clear that there is a mixing of influences from the Hellenic Arc and the Cyprus Arc; however, there is also a discontinuity between the arcs. It may be the episodic tectonic activity associated with the arcs that has produced the mix. Neotectonic deformation within the region of the Anaximander mountains appears to have begun only post-Miocene.

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Seismic Survey in the Eastern Algerian margin

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The Tertiary convergence of the Africa Eurasiatic plates has been characterised, in the Western Mediterranean region, by several phases of rifting involving creation of marginal basins as the Algero-Provençal, the Thyrrhenian and the South Balearic basins (AUZENDE *et al.*, 1973 ; BOCCALETTI and GUAZZONE, 1974 ; REHAULT *et al.*, 1984) and detachment of different blocs belonging to the Alpine chain (Corso-sarde bloc, Kabylian blocs).

As the Algerian margin remained one of the less surveyed area around the Western Mediterranean region, and in order to evaluate the structure of this margin, two seismic surveys were carried out in the Eastern part of the Algerian continental margin during 1973 and 1977 by the Algerian oil company in association with foreign companies.

Despite of the processing of the data was not performant, some important features have been revealed from the seismic lines.

The Eastern continental shelf displays large variations in its wideness from several tens of kilometers in the bays to few kilometers in front of the tellian chain. We also note that the wideness increases from the Bejaia gulf towards the Tunisian-Algerian border, to reach its maximum value in the region of the Galite island. This zone corresponding to the Sardinia-Tunisia strait, marks the transition between the Algero-Provençal basin and the Thyrrhenian basin.

The transition between the continental shelf and the abyssal plain is marked by an important step in the bathymetric values. The high declivity of the slope could have been generated by major NE-SW faults observed on the seismic profiles. Those important accidents also induce sedimentary slides towards the floor basin.

In the basin, the sedimentary cover displays several sequences lying on the acoustic basement as follows:

- a thick quaternary, pelagic or/turbiditic series.
- evaporitic series of Messinian
- Pre-Messinian series lying above a Miocene substratum

According to these data, we conclude that Algerian margin has been formed at the early Miocene. Since that time, a regular sedimentation occured with an exceptionnal salt crisis during the Messinian. From fluage of the salt, important salt domes have been formed.

In other hand, major deformations as shock occurences are mainly observed in the continental shelf. This indicates as suggested by AUZENDE *et al.*, 1975, that the African-European convergence is absorbed by continental formations or/an incipient subduction zone suggested by an important negative free air anomaly and the thickenning of the plioquaternary units towards the African continent.

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Biodiversité des Reptiles et des Batraciens en Région Méditerranéenne

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Située à la rencontre de deux continents, la région méditerranéenne possède une faune herpétologique et batrachologique d'origine variée. Les apports exogènes ou périphériques (asiatiques, sahariens, afro-tropical, euro-sibériens) représentent environ 38 % du total des espèces chez les reptiles et environ 43 % du total chez les batraciens. Comparativement aux oiseaux et aux mammifères dont l'endémisme méditerranéen n'excède pas 14 et 26,4 % respectivement (BLONDEL, 1986; CHEYLAN, 1990), ces deux groupes se caractérisent par une forte spécificité méditerranéenne puisque 56,4 % des batraciens et 62 % des reptiles sont inféodés à cette région.

A l'intérieur des limites bioclimatiques définies par EMBERGER *et al.* (1963), les reptiles sont représentés par environ 179 espèces, les batraciens par environ 62 espèces; ceci pour une surface d'environ 2 millions de kilomètres carrés, soit approximativement 1,3 % des terres émergées. A titre comparatif, la France continentale, qui représente environ le quart de l'aire considérée possède 27 batraciens et seulement 28 reptiles.

Chez les reptiles, la biodiversité maximale (nombre d'espèces/log de la surface prise en considération) s'observe au proche-orient (6,52), au Maghreb (4,5), dans les Balkans (3,9), dans la péninsule Ibérique et le sud de la France (2,6), sur les côtes libyennes (2,5) et enfin en Italie (1,7). Les îles, beaucoup plus pauvres, oscillent entre 2,19 pour le maximum (Chypre) et 1,21 pour le minimum (Corse) (Tableau).

Chez les batraciens, la richesse spécifique est à son maximum en péninsule ibérique-sud-France (1,6), en Italie (1,4) et dans les Balkans (1,3). Les rives sud et est sont quant à elles beaucoup plus pauvres du fait de l'aridité du climat. Sur les îles, les faunes batrachologiques les plus diversifiées sont celles de Sardaigne (0,9), Corse et Sicile (0,7); Baléares, Crète et Chypre étant nettement plus pauvres.

Les familles les mieux représentées en Méditerranée sont, chez les batraciens, la famille des Discoglossidés (71,4 % des espèces mondiales), les Salamandridés (35,8 %) et les Protéidés (16,6 %) et, chez les reptiles, la famille des Lacertidés (30 % des espèces mondiales), suivie de très loin par la famille des Trogonophidés (16,6 %), Testudinidés (8 %), Vipéridés (7,4 %) et Anguidés (5,3 %).

Parmi ces familles se rencontrent plusieurs genres endémiques à la région: genre *Chioglossa* (1 espèce), *Euproctus* (3 sp.), *Pleurodeles* (2 sp.), *Proteus* (1 sp.), *Salamandrina* (1 sp.), *Speleomantes* (6 sp.), *Discoglossus* (5 espèces dont une éteinte récemment). Beaucoup de ces genres sont archaïques et constitués d'un petit nombre d'espèces à distribution géographique limitée. Il en est de même pour les reptiles avec les genres *Testudo* (4 sp.), *Trogonophis* (1 sp.), *Blanus* (2 sp.), *Quedenfeldtia* (2 sp.), *Saurodactylus* (2 sp.) *Algyroides* (4 sp.), *Psammodromus* (4 sp.), *Podarcis* (15 sp.), *Macroprotodon* (1 sp.).

Compte-tenu de leur spécificité, ces deux groupes zoologiques mériteraient d'être pris en considération par les instances internationales et nationales ayant à charge la protection des faunes méditerranéennes.

Données récapitulatives concernant les faunes de Reptiles et de Batraciens de la région méditerranéenne.

BATRACIENS	MONDE	MEDITERRANEE	
		N	%
ESPECES	4015	62	1.5
GENRES	398	16	4.0
FAMILLES	34	8	23.5
Salamandridae	53	19	35.8
Proteidae	6	1	16.6
Plethodontidae	209	6	2.8
Discoglossidae	14	10	71.4
Pelobatidae	88	4	4.5
Bufonidae	339	4	1.1
Hylidae	637	4	0.6
Ranidae	611	14	2.3

REPTILES	MONDE	MEDITERRANEE	
		N	%
ESPECES	6457	179	2.7
GENRES	905	53	5.8
FAMILLES	48	17	35.4
Emydidae	91	3	3.2
Testudinidae	50	4	8.0
Trionychidae	22	1	4.5
Trogonophidae	6	1	16.6
Amphisbaenidae	133	2	1.5
Gekkonidae	800	18	2.2
Agamidae	300	5	1.6
Chamaeleonidae	85	1	1.1
Scincidae	1275	18	1.4
Lacertidae	200	60	30.0
Anguidae	75	4	5.3
Varanidae	31	1	3.2
Typhlopidae	163	2	1.2
Boidae	39	1	2.5
Colubridae	1562	42	2.7
Elapidae	236	2	0.8
Viperidae	187	14	7.4

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Données complémentaires sur l'espace menacé de Porto (Ile de Tinos, Mer Egée Centrale)

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Porto est une petite région côtière (3 km2) située au sud-est de l'île de Tinos, dans l'archipel des Cyclades en Grèce. Les principales caractéristiques de ce site ont été données dans une étude précédente (KYRTATOS, 1990).

Données complémentaires sur l'intérêt bio-écologique du site. Dunes et plages sableuses:

Porto comporte plus de la moitié des dunes de l'île de Tinos, rocheuse comme toutes les Cyclades. Les hautes dunes à calibrage fin homogène sont occupées par un Ammophiletum arenariae à *Ammophila arenaria* dominante (présence V, recouvrement 2a-3), les pré-dunes par l'Elymetum farcti avec pour espèces caractéristiques *Elymus farctus* (V, 1-4) et *Sporobolus pungens* (IV, 1-2a). Dans cette dernière association se rencontre l'orthoptère *Pyrgomorpha conica*. *Euphorbia paralias, Eryngium maritimum, Medicago marina, Pancratium maritimum* et *Otanthus maritimus* caractérisent les catégories supérieures et sont communes aux deux formations, avec une abondance particulière dans l'Elymetum. *Scirpus holoschoenus* peut être classée comme différentielle locale de l'Ammophiletum contre l'Elymetum farcti. En bord de mer, *Cakile maritima, Salsola kali* et *Euphorbia peplis* forment parfois des Cakiletea maritimae sur sable fin et grossier, graviers et feuilles mortes de posidonies. Les accumulations de feuilles mortes de posidonies échouées sur la côte sableuse d'Agios Ioannis Porto se caractérisent par *Orchestia montagui* et *Idotea basteri*. En arrière des dunes se rencontre, sur substrat meuble, une formation dense à *Ammophila;* sur substrat rocheux, une garrigue dominée par *Phrygana (Sarcopoterio-Ballotetum* acetabulosae) et, en milieu humide, au contact des roches, une végétation prédominée par *Vitex agnus-castus*. **Milieux humides:** ils sont particulièrement développés à Porto puisque l'on y rencontre de nombreux ruisseaux et un marais de près de 30 ha (KYRTATOS, 1990). **Poissons:** Les eaux qui entourent Porto accueillent de grands bancs de poissons et constituent un site de reproduction privilégié pour de nombreuses espèces. 1/4 à 1/3 des prises effectuées par les pêcheurs de Tinos (ca. 1-2 millions de kg) se font dans les eaux de Porto. Une des principales nourritures de plusieurs poissons pélagiques est l'ichtyoplancton. Les 270 tonnes de *Trachurus mediterraneus* pêchées annuellement prélèvent 138 tonnes de matière organique sous forme de larves et postlarves de poissons (KYRTATOS, en prép.). **Reptiles et mammifères:** de nouvelles observations de *Caretta caretta* ont été faites à Porto les 7.7.91 et 10.8.91. L'espèce nidifie encore au nord-ouest de la presqu'île d'Apokofto. *Monachus monachus* a été observé les 11.2.91 et 20.5.91. 4 grottes habitées ont été découvertes, dont deux aujourd'hui ruinées. Un phoque a été trouvé mort le 20.1.92 et il n'est pas rare de voir des phoques au sud et à l'est de la presqu'île d'Apokofto. Une dizaine d'individus circulent dans les parages de Tinos. Le 18-19 octobre 1989, trois individus ont été vus à Porto. Une femelle accompagnée d'un juvénile est entrée dans la baie d'Agios Ioannis au nord d'Apokofo. **Oiseaux:** l'estimation de la population avienne repose sur 20 années d'observations. La plupart de celles-ci ont été faites à partir d'un point fixe situé sur la presqu'île d'Apokofto, surtout pour le comptage des migrateurs, mais aussi à partir d'un bateau pour l'estimation des effectifs d'oiseaux marins. Nous avons également effectué des transects de plusieurs kilomètres pour comparer la station fixe avec le reste de Porto et pour avoir des dates complémentaires pour les migrateurs nocturnes. Les chiffres sont extrapolés de la facon suivante: valeur maximale pour chaque période sur un front de mer de 1,5 km pour la migration visible; sur la surface de Porto (3 km2) pour les sédentaires; sur le 1/4 de la surface de Tinos pour la migration non visible, tenant compte du fait que la migration d'automne se concentre sur Porto. Sont considérées nicheuses les espèces pour lesquelles on dispose d'indices sérieux de reproduction: accouplement, parades, nids. 150 espèces ont à ce jour été identifiées. La plupart des nicheurs *(Galerida cristata, Anthus campestris, Carduelis carduelis, Oenanthe hispanica* etc.) sont localisés dans la garrigue, le marais, la végétation bordant les ruisseaux et la côte escarpée. Les effectifs totaux dépassent certainement 7700 individus (28 espèces). La population avifaunistique estivale est estimée à 22500 individus (70 espèces dont 48 régulières). Celle-ci comprend environ 550 *Larus argentatus cachinans* et 550 *Puffinus puffinus* nicheurs. En été apparaissent 5000 *Puffinus puffinus,* 2400 *Larus argentatus cachinans* et 200 *Calonectris diomedea* qui, pour la plupart, se reproduisent sur les côtes rocheuses de Tinos. Lors de la migration d'automne, plus d'un million d'individus appartenant à 131 espèces passent par Porto. Ce sont surtout des *Coturnix coturnix, Streptopelia turtur, Hirundo rustica, Delichon urbica, Phylloscopus trochilus, P. collybita, et Acanthis cannabina* avec plus de 100 000 individus pour chacune des espèces. Les rapaces sont également nombreux: quelques centaines d'individus de *Pandion haliaëtus, Falco tinnunculus, Falco naumanni, Falco vespertinus, Falco eleonorae, Pernis apivorus, Buteo buteo* sont en effet observés à Porto. La population hivernale comprend environ 14 000 sédentaires (46 espèces) auxquels viennent s'ajouter 200 000 hivernants (101 espèces). Les sédentaires sont constitués pour l'essentiel de *A. cannabina, C. carduelis, G. cristata, E. calandra, E. cia, P. ochruroas, P. collybita et L. argentatus;* les hivernants par, outre les précédentes espèces, *Scolopax rusticola, Gallinago gallinago, Turdus philomenos, Anthus pratensis, Alauda arvensis, Fringilla coelebs et Erithacus rubecula*. La présence de *Larus audouinii* (min. 10 nicheurs, 40 présents) et l'abondance des *Puffinus puffinus* nicheurs font de Porto un site ornithologique d'importance internationale si l'on s'en réfère aux critères donnés par GRIMMET et JONES (1989). Plusieurs autres espèces menacées en Europe sont également bien représentées à Porto: *Anthus campestris* (environ 800 individus nicheurs) et *Falco eleonorae* (une douzaine environ sur la presqu'île d'Apokofto et Kouvaros). Non moins intéressants sont les migrateurs d'automne et de printemps tels que *Egretta garzetta* > 500 ind., *Plegadis falcinellus* env. 100 ind. et *Charadrius alexandrinus* > 100 ind. qui suffisent pour considérer les milieux humides de Porto d'importance internationale eu égard à la convention de Ramsar (critère de 1 % de la population européenne ou méditerranéenne, cf. GRIMMET et JONES, 1989). Il en est de même pour les populations hivernales d'*Aythya nyroca* et de deux autres espèces. En outre, les populations de 4 espèces observées à Porto *(Pelecanus crispus, Milvus milvus, Falco naumanni, Larus audouinii)* sont globalement en danger; 39 en danger au niveau européen et 8 ont une répartition géographique réduite, malgré d'importantes populations en Europe. **Nature des menaces:** Depuis 4 ans, le site naturel de Porto a été déclaré urbanisable malgré les nombreuses lois qui s'y opposent. Des plantations de *Tamarix* ont été conduites sur une partie des dunes entraînant la disparition des landes à *Ammophila*. 1/3 des ruisseaux, jadis bordés d'une végétation dense à *Nerium oleander* ont été transformés en route et au moins 1/20ème du marais est aujourd'hui détruit par suite d'apport de matériaux divers. Plusieurs espèces hygrophiles -batraciens, reptiles- ont d'ores et déjà disparu. Il faut donc craindre, à court terme, la régression voire la disparition des dunes et du marais ce qui aurait de graves conséquences pour les populations animales menacées de Tinos.

Conclusion: Porto est un site remarquable au sein des Cyclades et de l'Egée. A ce titre, il mérite d'être protégé dans les plus brefs délais. Des propositions ont déjà été faites dans ce sens depuis une dizaine d'années par le Centre de Recherches Marines et Côtières, soutenues par des organisations comme la Fondation Patrimoine naturel en Europe, le Goulandris National History Museum et le Greek Red Cross, ainsi que par diverses recommandations ministérielles. Jusqu'à présent, ces recommandations n'ont pas été suivies par les autorités locales.

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I

Density distribution of spiders and pseudoscorpions. Spatial and temporal patterns in a Mediterranean Type Ecosystem, Aegean Sea, Greece

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Introduction

In the framework of a wider study on the community structure of the soil arthropods which was begun in 1984 and completed in 1991, an attempt to examine the distribution of spiders and pseudoscorpions, two of the more abundant soil arthropods, in a typical insular ecosystem in the Aegean sea was also made. The study area is a maquis ecosystem on the island of Naxos (Cyclades), where the degraded woody shrubs (due to overgrazing by goats) of *Quercus coccifera* and *Pistacia lentiscus* dominate. The climatic conditions in this area of the central Aegean, according to our measurements are characteristic of a xero-thermo-mediterranean climate.

Methods - Results and Discussion

In order to measure the density of these two groups in the entire ecosystem as well as in the main microhabitats of the soil arthopods, 6 squares 1x1m in the clearings (open ground) and 10 squares 0.25x0.25m in the litter of each of the main shrubs were taken on a monthly basis from March 1984 until April 1986. For the extraction of the animals the Rothamsted method was used. The results concerning the phenology and density distribution of the spiders and pseudoscorpions in the all ecosystem and in the litter of the dominant shrubs or in the clearings under the stones, as well as the seasonal density variation are given in Table I and in Figure 1. In Table II the main coefficient values concerning the spatio-temporal patterns are given.

Groups	Total Ecosystem ind/m²	Litter Q.coccifera ind/m²	Litter P.lentiscus ind/m²	Clearings ind/m²	Spring ind/m²	Summer ind/m²	Autumn ind/m²	Winter ind/m²
Pseudosc.	14.12	55.63	37.83	0.07	8.61	0.40	8.99	34.56
Spiders	11.27	37.74	27.49	2.90	15.11	4.14	7.40	15.52

Table I. Distribution and seasonal variation of the density.

According to the data in Table I & Fig. 1, it is obvious that both groups prefered the litter microhabitat and especially that of *Q. coccifera*. Concerning Pseudoscorpions the highest density values were noted during the winter and in the early spring with a peak in January,while during the warm and dry period (late spring until middle autumn) the respective values were very low. On the contrary, spiders have more or less a continuous presence during an annual cycle and its peak appeared during the April. According to TAYLOR's law and the regression coefficient values β_s and β_t, (TAYLOR & WOIWOD, 1982), was proven that both groups have aggregated spatio-temporal patterns and consequently display a contagious distribution. It must be noted that in this case, in order to avoid considering a Poisson distribution as contagious, all the samples for which the mean density value ≤ 1 were not taken into account.

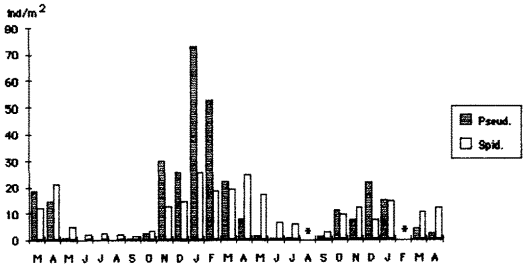

Figure 1 : Phenology of Pseudoscorpions and Spiders in the all ecosystem from March 1984 - April 1986 (*) : no samples taken.

	β_s	a_s	r_s	r_s^2	SE_s
Pseudosc.	1.308	1.003	0.837	0.700	0.330
Spiders	1.559	0.598	0.748	0.599	0.281
	β_t	a_t	r_t	r_t^2	SE_t
Pseudosc.	1.893	0.648	0.923	0.853	0.242
Spiders	1.852	0.652	0.703	0.494	0.299

Table II. Coefficient values of spatio-temporal patterns.

As was proven, a determinat role of the density distribution is played by the available quantity and particularly the quality of the microhabitats and refuges, while seasonal variation is defined by the climatic conditions and the life cycle of the species. Based on comparisons which took place between the ecosystem under examination and other ecosystems in Greece and ecosystems of other mediterranean-climate regions in Egypt and Chile, the values of relative abundance of Pseudoscorpions and Spiders are among the highest on Naxos.

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Los vertebrados del Pleistoceno Superior de las Pituisas: algunas implicaciones biogeograficas

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Una caracteristica de las faunas fosiles del Pleistoceno de las grandes islas del Mediterraneo es que contienen especies endémicas de mamiferos terrestres no voladores. Estas faunas son asimismo sumamente pobres, en comparacion con las coetaneas continentales y las actuales. En cada isla o archipiélago vivian solo unos pocos taxones: hipopotamos, elefantes, ciervos, gorales, nutrias y algunos roedores e insectivoros. En las islas de Mallorca y Menorca (Gimnesias) la especie mejor conocida es el goral enano *Myotragus balearicus* (BATE, 1909), extinguido, como casi todos los mamiferos que formaban parte de las faunas prehumanas de las islas mediterraneas tras la llegada del hombre a las islas.

En las islas Pitiusas (Eivissa y Formentera), a pesar de haber sido exploradas paleontologicamente desde principio de siglo (BATE, 1914), no se localizaron yaciminetos de vertebrados fosiles hasta la década pasada (ALCOVER *et al.*, 1981, MOYA *et al.*, 1984). En la actualidad se conoce un yacimiento miocénico (Ses Fontanelles) que ha librado una fauna insular de afinidades inciertas, un yacimiento atribuido al Plioceno superior (Cova de Ca Na Reia), y siete yacimientos del Pleistoceno medio-superior. En el yacimineto de la Cova de Ca Na Reia ha aparecido una fauna insular que comprende una largatija, *Podarcis* sp., una tortuga terrestre de talla media, *Cheirogaster* sp. (BOUR, 1985), diversas aves fosiles, entre las que destaca *Puffinus nestori*, considerada la especie ancestral de los *Puffinus* mediterraneos, dos gliridos y un bovido (ALCOVER & AGUSTI, 1985, ALCOVER, 1989). En este yacimiento aparecen también restos de gasteropodos. En Cala Salada, Eivissa, se conoce otro yacimiento que a pesar de no ser estrictamente coetaneo con el de la Cova de Ca Na Reia, ha librado una fauna de gasteropodos terrestres que representa el mismo episodio faunistico. Entre la Cova de Ca Na Reia y Cala Salada se han detectado 16 especies de gasteropodos terrestres (PAUL, 1982, 1984).

Los yacimientos del Pleistoceno medio-superior de las Pitiusas presentan una caracteristica comun notable: en ninguno de ellos han aparecido restos de mamiferos terrestres no voladores. La fauna librada por estos yacimientos consiste en cuatro especies de gasteropodos, una lagartija, aves y quiropteros. El yacimiento mas importante del Pleistoceno superior de Eivissa es Pouàs. En dicho yacimiento desde hace tres anos se esta realizando una excavacion que hasta la fecha ha librado mas de 100.000 huesos de aves, asi como decenas de miles de huesos de la lagartija *Podarcis pityusensis*, y unos pocos centenares de huesos de quiropteros y de peces. Entre las aves se encuentran numerosas especies que actualmente no crian en Eivissa, pero que si lo hacian en el momento de la deposicion de los materiales (aparecen numerosos huesos de ejemplares juveniles): *Haliaeetus albicilla, Pyrrhocora pyrrhocorax*, diversas anseriformes, etc. (FLORIT *et al.*, 1989, ALCOVER & MCMINN, 1992). La fauna librada por este yacimiento permite establecer diverentes conclusiones que tienen implicaciones biogeograficas:

1. Durante el Pleistoceno superior las Pitiusas eran unas carentes de mamiferos terrestres no voladores. En el ambito mediterraneo parecen haber sido las unicas islas de gran extension que presentaban esta caracteristica. Este hecho es sorprendente tanto por haber tenido faunas de mamiferos en el Plioceno y en el Mioceno, como por tratarse de unas islas relativamente cercanas al continente (90 km).
2. Los datos de los que se dispone apunta hacia una inflacion de aves en el Pleistoceno superior de las Pitiusas. La fauna ornitica prehumana era mas rica que la actual.
3. El numero de especies de moluscos terrestres se ha multiplicado casi por diez desde la llegada del hombre a las Pitiusas. Ninguna de las especies que aparecen en el registro pleistocénico superior se ha extinguido tras la llegada del hombre.
4. Se confirma que todos los mamiferos terrestres no voladores que viven actualmente en las Pitiusas son introducidos, voluntaria o involuntariamente por el hombre.
5. La fauna de quiropteros del Pleistoceno de las Pitiusas es mas rica que la actual. La mayoria de las especies cavernicolas de quiropteros han desaparecido recientemente de las Pitiusas.
6. Muchos grupos faunisticos han debido colonizar recientemente las Pitiusas: sifonapteros especificos de mamiferos terrestres no voladores, nematodos que parasitan estas especies, coleopteros coprafagos, etc.

El estudio de las faunas fosiles prehumanas se revela, por lo tanto, imprescindible para interpretar las faunas actuales. La dilucidacion de la naturaleza autoctona o no de las diferentes especies que actualmente viven en las Pitiusas es un reto de primer orden para la realizacion de analisis biogeograficos de este archipiélago.

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Diversité des Musaraignes du genre *Crocidura* en Méditerranée

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Une dizaine d'espèces de Musaraignes appartenant au genre *Crocidura* occupent l'aire géographique méditerranéenne (CORBET, 1978; NIETHAMMER et KRAPP, 1990). Les difficultés d'identification rencontrées dans ce groupe se sont trouvées en partie résolues ces dernières années par l'utilisation d'analyses cytologiques et biochimiques (VOGEL *et al.*, 1990). Il est donc aujourd'hui possible de dresser un inventaire assez complet de la distribution géographique des musaraignes sur les îles méditerranéennes.

Sur une centaine d'îles pour lesquelles on possède une liste des espèces de mammifères, seules 33 abritent des Musaraignes, dont 31, une espèce et seulement 2 avec deux espèces: la Crète et Lesbos (Tableau).

Celles-ci se rattachent à six taxons :

C. suaveolens (PALLAS 1811) apparaît sur 22 îles dont la superficie varie de 12.5 à 9250 Km^2.

C. russula (HERMANN 1780) est restreinte à la Méditerranée occidentale oùelle n'a été trouvée que sur 3 îles, et peut-être 4 si le statut de l'espèce sur l'île de La Galite est confirmé.

C. leucodon (HERMANN 1780) ne se rencontre que sur l'île de Lesbos.

C. sicula (MILLER 1901), dont le statut taxinomique vient d'être établi occupe la Sicile et toutes les îles circumsiciliennes; la population de Malte est éteinte.

C. zimmermanni (WETTSTEIN 1953) est endémique de Crète.

C. cossyrensis (CONTOLI 1989) vient d'être décrite de Pantelleria par CONTOLI (1990) sur la base de critères morphométriques.

Origine du peuplement.

Des recherches archéozoologiques menées ces 20 dernières années ont montré que l'essentiel sinon la totalité des faunes mammaliennes insulaires ont été amenées par l'homme (VIGNE et ALCOVER, 1985). Il semble que ce soit le cas pour *C. russula* et *C. suaveolens* dont la présence sur les îles n'est attestée qu'à partir de l'arrivée de l'homme préhistorique. Aux Baléares, *C. russula* a été trouvée dans un gisement daté du XVII-XVIIIe siècle AD. et *C. suaveolens* vers 200 BC sur Minorque. En Corse, cette dernière est mentionnée avant le début de notre ère (VIGNE et ALCOVER, 1985). Cette espèce se retrouve également en Crète dans des gisements datant de 1500 BC (REUMER et PAYNE, 1986). Par contre, *C. zimmermanni* et *C. sicula* sont déjà présentes au Pleistocène (VOGEL *et al.*, 1990).

Evolution en milieu insulaire.

Elle se traduit chez les Crocidures, par une augmentation de la taille du corps; augmentation qui atteint 11% chez la population de Corse (POITEVIN *et al.*, 1987). Cette tendance se manifeste également à Chypre entre l'âge du Bronze et l'actuel (REUMER et OBERLI, 1988). Ces deux exemples montrent que cette évolution peut être trés rapide. Cette caractéristique pourrait être due à l'absence de compétiteur.

La divergence génétique de ces populations est variable, comme l'indiquent les distances de Nei trouvées entre population insulaire et continentale: Minorque/ France = 0.007; Corse/France= 0.065; Porquerolles/France = 0.0018; Ibiza/Espagne = 0.122 (CATALAN *et al.*, 1988); Crète/Turquie = 0.003 (VOGEL *et al.*, 1986); Chypre/ Israel = 0.113; Sardaigne/Suisse = 0.076 (CATZEFLIS *et al.*, 1985).

Conclusion.

Avec 6 espèces le genre *Crocidura* est l'un des plus diversifié dans l'espace méditerranéen. Il comprend deux endémiques insulaires, et montre, chez les espèces d'introduction récente, des degrés de différenciation qui peuvent dans certains cas être trés marqués.

Tableau: Distribution des Crocidures sur les îles méditerranéennes († population éteinte).

ILE	C. suaveolens	C. russula	C. leucodon	C. sicula	C. zimmermanni	C. cossyrensis	SURFACE Km2
CHYPRE	+						9250
CORSE	+						8747
CRETE	+				+		8330
LESBOS	+		+				1650
RHODES	+						1400
MINORQUE	+						668
CORFOU	+						600
SAMOS	+						468
CRES	+						404
KRK	+						409
ELBE	+						232
KORCULA	+						279
LASTOVO	+						53
CAPRAIA	+						19.5
FAVIGNANA	+						19
PORQUEROLLES	+						12.5
CHIOS	+						
BRAC	+						
KOS	+						
THASOS	+						
EUBEE	+						
KITHIRA	+						
PANTELLERIA						+	83
MALTE				+†			316
SICILE				+			25700
GOZO				+			67
MARETTIMO				+			12
USTICA				+			8.1
LEVANZO				+			6
SARDAIGNE		+					24078
IBIZA		+					572
LA GALITE		+?					
MEDAS		+					0.16

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Malthonica Simon, 1898 (Araneae, Agelenidae): un género endémico del Mediterraneo

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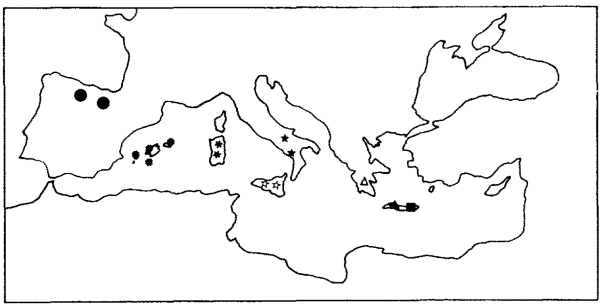
Entre los endemismos mediterraneos del orden Araneae se encuentra un género especialmente significativo desde el punto de vista zoogeografico: *Malthonica* Simon, 1898 (Araneae, Agelenidae).

El género tiene una distribucion claramente mediterranea. BRIGNOLI (1978) insinua una posible relacion entre *Malthonica lusitanica* (de la Peninsula Ibérica), *Malthonica balearica* (hasta entonces conocida unicamente de Mallorca y Menorca), *Malthonica sarda* (de Cerdeña), *Malthonica sicana* (de Sicilia) y *Malthonica arganoi* (de Italia centromeridional) que sugiere una posible relacion zoogeografica de estas zonas: Unidad Peninsula Ibérica e Islas Baleares con el complejo Cerderña-Sicilia-Italia. Mas recientemente se han descrito nuevas especies del género; *Malthonica minoa y Malthonica deadeli* (de Creta) y *Malthonica paraschiae* (de Grecia) (BRIGNOLI, 1980; 1984). Estos nuevos taxones amplian la zona de distribucion del género hacia el area mas oriental del Mediterraneo.

Malthonica balearica hasta ahora tan solo habia sido recolectada de las islas de Mallorca y de Menorca, considerandose un endemismo gimnésico (BRIGNOLI, 1978; BARRIENTOS & FEBRER 1986). Diversas campañas de recoleccion llevadas a cabo por el "Institut d'Estudis Avançats de les Illes Balears" (CSIC) por casi todas las islas y islotes de las Baleares (Gimnesias y Pitiusas) han aportado nuevos datos sobre su distribucion.

Durante una campaña intensiva realizada durante 1990 para la realizacion del "Pla d'Ordenacio dels Recursos Naturals del Sector Nord de la Serra de Tramuntana" (PONS & PALMER, 1990) se analizaron datos zoologicos de casi 250 cuadriculas de 1 km2, combinando los muestreos directos con la colocacion de trampas de intercepcion para invertebrados. Resultados de esta campaña indicaron que *Malthonica balearica* era la especie, con diferencia, mas abundante de la zona con una mayor densidad en areas con cobertura vegetal arborea *(Pinus halepensis y Quercus ilex)*. Estos resultados se han visto corroborados en posteriores visitas a las distintas islas del Archipiélago Balear. Sa Dragonera, isla situada en el sector sudoccidental de Mallorca y con una superficie aproximada de 3 km2 cuenta entre sus comunidades vegetales con *Rosmarino-ericion* en expansion. Esto favorece la presencia de *M. balearica*. No obstante, Sa Dragonera cuenta con una baja densidad de la mayoria de especies de invertebrados debido a la elevada densidad de *Rattus rattus* (ALCOVER *et al.*, 1990). PONS (en prensa) cita esta especie de la isla mayor del Archipiélago de Cabrera, isla de Cabrera, que es la unica que cuenta con las condiciones fitosociologicas adecuadas para la instauracion de esta especie. Otra isla del Archipiélago Balear donde se ha recolectado esta especie es la Illa den Colom, situada al noreste de Menorca en la que existe un pequeño pinar. Por ultimo, *M. balearica*, fue recolectada en Eivissa pasando asi a ser una especie distribuida, al menos, en las tres islas mayores, asi como en las islas con una superficie suficiente para albergar comunidades vegetales arboreas (Sa Dragonera, Cabrera e Illa den Colom).

Tanto la distribucio geografica del género, como su diversificacion en distintas formas endémicas locales y su, aparentemente, limitada capacidad de dispersion hace considerar al género como idoneo para la realizacion de analisis biogeograficos de ambito Mediterraneo, como los realizados en base a otros grupos por OOSTERBROEK & ARNTZEN (1992).



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Project OTPESEM: the fate of organic pollutants in the environment. Extractable organic matter

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Project OTPESEM (Organic Tracers of Pollution in the Environment of the South-Eastern Mediterranean) is a new non-traditional research project in the South-Eastern Mediterranean. The aim of the project is to: (1) identify specific organic molecular markers (hydrocarbons and PAHs) in aerosols, water and sediments; (2) assess fecal sterols and sterones as indicators of urban sewage inputs to Alexandria (Egypt) coastal waters; (3) provide preliminary data on the levels and distributions of indicator microorganisms in domestic sewage-impacted areas for confirmation of pollution; (4) study the distributions, concentrations and fluxes of linear alkylbenzene sulfonates (LAS); and (5) carry out complete statistical analyses of the data in order to evaluate the transport pathways, the regions of concentration, the annual fluxes of selected organic pollution tracers, and to conceptually model the environment. The lack of information about the organic geochemistry of the Alexandria coastal environment initiated this extensive study of organic pollution tracers in the Alexandria metropolitan area. In this paper, our objectives are to report the impact of sewage disposal on the percent and composition of total solvent soluble organic matter. In addition, identification of statistically significant end members, representative of the study area and a conceptual model of the environment of Alexandria are also presented. Alexandria is the principal summer resort of Egypt. It is one of the densely populated regions of the Eastern Mediterranean. The problem of organic pollution of the Alexandria coastal environment has been and is still discussed on a national and multinational scale. The problem is identified as industrial versus agricultural pollution on one hand and sewage pollution on the other. The domination of either depends mainly on the disposal location. The study area (Fig. I) lies off Alexandria between 31°08'-31°26'N and 29°47-30°04'E, extending for about 38 km from El-Agami to Abo-Qir headland. According to the type of regional impact, the coastal waters can be divided into six main zones (Fig. 1). Zone I (beaches) receives a significant amount of untreated sewage ($36x10^6$ m^3/yr); zones II (Eastern Harbor) and III (Western Harbor), the main trading and fishing harbors of the city, receive waste water and untreated sewage ($35x10^6$ m3/yr); zone IV (Kayet Bey) receives domestic sewage from the main metropolitanpumping station ($112x10^6$ m^3); zone V (El-Mex Bay) receives various industrial waters from several outfalls: agricultural ($2200x10^6$ m^3/yr) and chlor-alkali plant ($13x10^6$ m^3/yr); and zone VI (El-Agami) is regarded as the reference area receiving little local discharge.

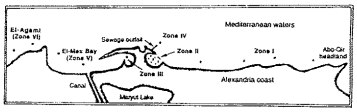

Figure 1: The study area of Alexandria City

Surficial bottom sediments were collected from the study area using a modified Ekman grab, and frozen until analysis. Air dried, sieved samples were Soxhlet extracted with methylene chloride-methanol. This extract after water washing is a measure of the amount of extractable organic matter in the sample (%EOM). The extracts (EOM) were concentrated, hydrolyzed, separated into acidic and neutral fractions, esterified and fractionated by column chromatography. The following fractions were collected: F1 alkanes and alkenes, F2 monoaromatic hydrocarbons, F3 PAHs, F4 esters and ketones, F5 ketones, and F6 alcohols. Assessment of hydrocarbon pollution in a contaminated aqueous environment is generally not conclusive because of changes in waste water discharges, variation in the predominance of certain sources and/or irregular local emissions. The application of the concept that aquatic sediments act as pollutant sinks may overcome this drawback because sediments provide an integrated picture of the events taking place in the water column. For this reason, surficial sediment samples have been analyzed from the Alexandria environment. The %EOM in the area is high compared with other contaminated coastal environments. The HC content the EOM ranges between 18% in the reference area to 66% in zone V. The concentrations of the different extract fractions indicate that alcohols represent about 40, 55 and 28% in zones I, IV and VI, respectively. PAHs represent about 41% of HC in zone V, while alkanes & alkenes represent about 56% in zone II & III.

Table 1: Extractable Organic Matter Composition in the Different Zones of Alexandria

				EXTRACT FRACTIONS (µg/g dry weight)					
ZONE	%O.C.	%EOM	% HC/EOM	F1	F2	F3	F4	F5	F6
I	2.08	0.4112	32.5	312	214	189	291	318	876
II & III	3.07	0.5565	48.3	509	228	176	266	217	494
IV	3.60	0.7811	30.1	417	298	312	241	274	1871
V	4.10	0.8910	56.5	321	301	431	328	228	256
VI	1.50	0.0701	18.0	78	12	50	212	203	212

According to HAMILTON-TAYLOR (1979), a way to convert the sedimentation rate to a weight basis is to use the following formula: **Bulk sedimentation rate (F)=R (1-p)d**, where **R**= sedimentation rate, **p**= porosity and **R**= density. According to ABOUL-DAHAB *et al.* (1990), the sedimentation rate in El-Mex Bay is 0.85 cm/yr, and the average density and porosity of sediments in the bay are 2.6 g/cm^3 and 0.75%, respectively. So, F will be equal to 0.6 $g/cm^2/y$ or 15 $g/m^2/d$. Using the average hydrocarbon concentration in the sediments of El-Max Bay (1053 µg/g, Table 1), and given the surface area of the bay ($19.4x10^6/m^2$), the hydrocarbon sedimentary flux for the whole bay would be: $(15)x(19x10^6)x(1053\ \mu g/g)=300$ kg/d. In other words, the sedimentary flux for the different fractions of the extract in El-Mex Bay were: 92, 86, 123, 94, 65 and 73 kg/d for F1 to F6, respectively. Q-mode factor analysis is based on grouping a multivariate data set based on the data structure defined by the similarity between samples. By applying this technique to our data, two significant principal factor loading scores were obtained, giving information about the sample variation of about 93.2% and 4.96%, respectively. The factor loading matrix represented the sample representation in the model and indicated the importance of each of the factors or end members in each sample. After varimax rotation of the composition scores, two significant end members resulted, dominated by the variables as fraction I (alkanes and alkenes) and fraction 6 (alcohols), respectively. Because the transfer of the original data variables during the analysis results in negative factor scores for some variables and negative concentrations of some variables in the end members, the use of a non-orthogonal rotation of end member vectors, toward the mean vector was used to bring the end members into positive vector space. By using a linear programming technique (LPT), a set of equations was applied for correcting the initial end member compositions and their abundance to better fit the observed multivariate data set. This helped to specify and select the compositions of the end members, so that they are close to the true compositions. The alkanes and alkenes as the first end member is representative of the Alexandria environment, polluted with oil from ships in both its harbors and El-Mex Bay as well as waste water disposal. The importance of the second end member (alcohols) comes from the dominance of coprostanol (5ß-cholestan-3ß-ol) which is used as a fecal pollution indicator. In conclusion, a significant fraction (20%) of the total solvent extractable matter consists of inorganic salts which should be taken into consideration in quantitative analysis of HC. The reference zone is obviously different than the other polluted zones with varying levels HC. By applying factor analysis to these data, two significant end members were defined as alkanes & alkenes and alcohols, respectively. Future work concerning the molecular composition of the different fractions, qualitatively and quantitatively, will be useful in constructing the Alexandria environmental organic tracers model.

Haematological changes and light microscope study of peripheral blood cells in the European eel exposed to lead concentrations

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The increasing density of population and rapid development of industries, especially the chemical industries has created serious problems in water pollution. Trace elements introduced into the marine environment from effluents and river runoff, may be concentrated in marine organisms, this means that marine organisms can store pollutants and then transfer them even to human beings.

The extensive studies on morphological and physiological changes in the blood of fish exposed to toxic chemicals and varying degrees of environmental stressors have been documented by many authers. The purpose of this study was to determine the potential hazard of lead in water on fish which consider the end of the aquatic foodchain, and its hazardous to public health, by the determination of the pathological diagnosis of the blood.

The used material consisted of 80 specimens collected alive from Lake Edku. Plastic aquaria, contained 35 liters of sea water and 5 fish. Lead was added as a lead nitrate with concentrations of 1.0, 1.5 mg/L for 10, 20 and 30 days and 15.0 mg/L for 7 days. Blood was taken from dorsal aorta to the determination of haemoglobin, haematocrit, red and white blood cell count. The preparation or blood smears were stained with May-Grunwald Giemsa stain.

The exposure of European silver eels to lead revealed a significant decrease in haematological studies with limits; observed in control. Microscopical examination or RBCs of such poisoned fish revealed rapid and striking change amony these cells. Many of these were either in early stages of hemolysis or in advanced stages. The cells membranes were removed with only ghost remaining in some cases, these cells were enlarged, assuming various shapes, pear, avoid, amorphus or circular. The presence of the red cell hypochromic, microcytes, variable number of stippled cells, marly number of target cells with sikle cells and irregular poikilocytes

The leukocytes are an important part of the body's defense system, therefore, after examination of the blood collected 10 days after exposure to 1.0 and 1.5 mg/L lead, showed the lymphocytes as small mononuclear cells, an abundance of both mature and immature neutrophils, small significat change occured in monocytes and eosinophils count. Lymphopellia and neutrophilia cells, noted during the experiment after 20 and 30 days in mature stage, the number of monocytes increased while the number of eosinophils mainly in small change.

Total leukocyte count significantly decreased when exposed to 15. 0 mg/L lead and after 7 days. The responsive cell types in all experimental groups were the lympocytes, neutrophiles and monocytes.

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Micromycetes de la zone littorale polluée de la Mer Noire

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Au cours de l'année 1990 nos études ont visé la dynamique des populations de champignons devant 7 stations, entre Mamaïa et Vama Veche, à l'horizon 0 m, aux profondeurs de 0, 0/5 et 0/10 m, d'où l'on a prélevé 62 échantillons pendant la période juin-septembre (Fig.1).

Le degré accru d'infestation des eaux littorales a été marqué par l'extrême prolifération des formes levuriformes de champignons allochtones.

Les niveaux de densité réalisés sur les deux isobathes (0/5 et 0/10 m) et au rivage prouvent l'influence des sources terrigènes de pollution agissant depuis les points de déversement vers le large, et du nord au sud.

Les modifications observées sur toute la zone littorale sont l'augmentation du taux des levures et la réduction toujours accrues des espèces filamenteuses dans le mycoplancton.

Du point de vue quantitatif, les productions moyennes de spores par unité de volume d'eau ont augmenté jusqu'à quelques milliers de propagules. l^{-1}, ce phénomène constituant un vrai problème pour les activités estivales et touristiques normales.

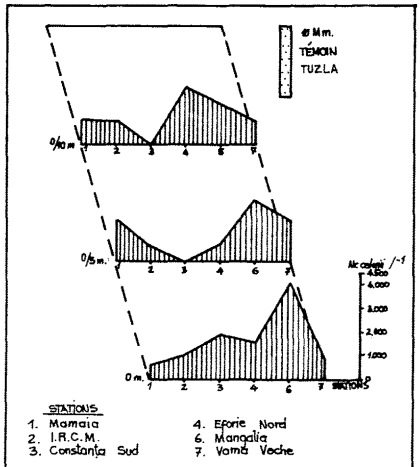

Fig. 1 - DISTRIBUTION DES CHAMPIGNONS POTENTIELLEMENT PATHOGÈNES D'APRÈS LA DISTANCE DE LA CÔTE

Les espèces dominantes, beaucoup d'elles pathogènes, ont eu une fréquence de plus de 50 % dans les échantillons, sans tenir compte de l'isobathe ou du point d'investigation.

Par rapport à la période 1975-1982 (APAS, 1982, 1985), l'état actuel d'infestation des eaux prouve des modifications brutales en structure, ainsi qu'en densité, par la prolifération de certaines formes spécifiques aux zones polluées (*Penicillium* sp., *Cladosporium* sp., *Candida* sp., *Rhodotorula* sp., *Geotrichum* sp.,etc.). Ce phénomène de prolifération a déterminé des processus de "floraison fongique" au cours des mois de déroulement de l'activité estivale maximale (juillet - septembre).

De grandes productions de spores (blastospores, arthrospores) ont été obtenues à Mamaïa, Eforie Nord et Mangalia.

Dans la station témoin du large, Tuzla, les valeurs furent comparables aux autres stations au cours des mois de juin et de juillet, enregistrant ensuite des diminutions vertigineuses pendant les autres deux mois (août, septembre).

Les analyses mycologiques de cette année situent les eaux du littoral roumain parmi les eaux polluées. L'analyse quantitative des champignons, et surtout de ceux à capacités pathogènes, a prouvé la diffusion des produits chimiques et biologiques de pollution sur de grandes étendues de la mer, influençant en même temps les eaux de la station témoin Tuzla.

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Eutrophication Monitoring in Malta (Central Mediterranean)

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No comprehensive reports about environmental conditions which may lead to coastal eutrophication in Malta have been made as yet. Two main harbours which were investigated, lie on the NE coast of Malta (figure 1) and are situated in the most densely populated part of the main island. The **Grand Harbour** includes Malta's major ship yards, a tank cleaning facility and a power station located at its innermost part. Most of the harbour is approximately 10-20m deep **Marsamxett harbour** is deeper, reaching depths of 30 m in its central region. It surrounded by touristic localities, including a recently developed yacht marina and a yacht repair yard.

The paper reports on data collected during a 3-year programme (1989-1991) where several parameters, including phosphates, nitrates plus nitrites and chlorophyll A levels (measured according to PARSONS *et al.*, 1984), were monitored at 14 fixed stations. **Table 1** summarises the data on some parameters at a selection of such stations (data on all stations will be given in the full text of the paper). Surface temperatures in the Grand Harbour were generally higher than those at Marsamxett or the reference station, with peak values being recorded close to the power station. Water stratification durring the summer months was evident in all stations. Salinity fluctuations were minimal except at the innermost stations at Marsamxett, with minima of 16.4 and 34.4 ppt being recorded after heavy rainfall. No anoxic conditions were ever reported in bottom waters though minima ranging from 3.3 to 4.8 ppm were sometimes recorded in the bottom waters of the inner creeks at Marsamxett and Grand Harbour.

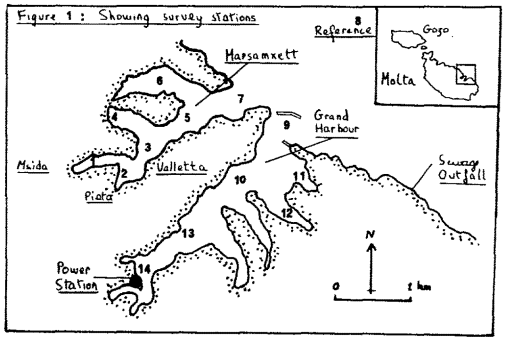
The transparency of the waters decreased significantly from the reference station towards the innermost parts of both harbours where minima ranging from 1.2 m to 1.8 m were recorded in various months. The degree of correlation between chlorophyll A contents and water transparency was found to be low, indicating that much of this reduction in water transparency is due to inorganic suspended matter released into the water column as a result of dredging activities in both harbours. Nutrient levels at the reference station were generally typical of coastal inshore waters, though on some occasions, very high levels of phosphates (4.7 µg-at P/l) and nitrates (24.2 µg-at N/l) were recorded here. Though this happened quite rarely, it shows that this station was sometimes under the influence of the nearby major sewage outfall at Wied Ghammieq (Figure 1) which is approximately 2 to 3 km away on the eastern side of the Grand Harbour. On the whole, nutrient levels were generally higher in Marsamxett than in Grand Harbour. Particularly high levels of phosphates (eg. 7.6 µg-at P/l) were found in Marsamxett during dredging activities, and this may be one of the major factors contributing to elevated nutrient levels in this harbour. Nitrate (plus nitrite) maxima ranging from 22 to 45 µg-at/l were also more frequently reported here, being comparable to nitrate levels reported from highly eutrophic areas such as Elefsis Bay, Greece (eg. FRILIGOS, 1988).

Chlorophyll A levels in most stations in Marsamxett were generally higher than those from the Grand Harbour with maxima ranging from 2.4 to almost 9 µg/l being recorded especially from October to January. These levels were found to be well correlated with phosphate and nitrate levels, with correlation coefficients of 0.399 and 0.385 being reported, respectively (both significant at the 1% level). Levels of chlorophyll A were generally uncorrelated with water transparency. This again points out that any reduced water transparency was mostly due to the increased occurrence of suspended matter in the water column. Surprisingly enough, levels of chlorophyll A in the innermost stations at Grand Harbour were generally quite low in spite of the elevated nutrient levels (as well as high ambient temperatures). This shows that some limiting factor(s) other than availability of nutrients must be affecting productivity within this area.

In conclusion, while nutrient levels were in some cases comparable to other coastal Mediterranean regions which have exhibited evident signs of eutrophication, primary productivity as monitored by chlorophyll A contents was never significantly high. Most of the nutrient loads were probably derived from dredging activities in the areas. Whether these elevated nutrient levels may eventually lead to hyperproductivity and algal blooms, and if so, what would be the factors which may trigger this effect, are two questions which still need to be answered by the present on-going environmental monitoring programme which is being conducted in the area. The present study has also shown that one major impact on the local coastal water characteristics, is the thermal emissions of the present power station in the Grand Harbour. The nature and spatial extent of the associated environmental impact still need to be determined.

Table 1: Mean values (9 replicates) and ranges of some selected parameters at surface (s) and bottom (b) waters at some of the stations shown in Figure 1, for Marsamxett (MX) and Grand Harbour (GH) during 1989-1991. All data on all stations will be presented in the full text.

	Station:	MX1s	MX1b	MX3s	MX3b	Ref.s	Ref.b	GH13s	GH13b	GH14s	GH14b
Secchi Depths	**Mean:**	3.6		4.0		11.7		2.7		2.6	
(m)	Max:	5.8		6.0		14.3		3.8		4.0	
	Min:	2.0		1.2		6.0		1.6		1.8	
Phosphates	**Mean:**	1.5	1.1	1.6	1.1	0.7	0.1	0.6	0.6	0.8	0.7
(µg-at P/l)	Max:	2.8	2.6	5.5	4.2	4.7	0.2	1.3	1.3	2.9	3.5
	Min:	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.0
Nitrates/	**Mean:**	26.4	13.6	17.8	19.8	9.9	13.9	13.5	12.1	14.9	16.3
Nitrites	Max:	45.0	26.8	36.6	43.2	24.2	28.7	27.4	23.7	28.9	25.5
(µg-at N/l)	Min:	10.8	3.1	2.0	1.0	2.1	4.4	2.8	1.2	2.8	1.6
Chlorophyll A:	**Mean:**	1.6	1.9	1.6	2.0	0.6	0.3	1.0	0.8	0.7	0.6
(µg/l)	Max:	4.2	7.1	5.3	5.8	1.8	0.7	2.7	2.3	2.1	1.7
	Min:	0.1	0.1	0.2	0.1	0.1	0.0	0.2	0.3	0.0	0.0



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Mercury contents in *Eledone cirrhosa* from the Northern Tyrrhenian Sea

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It is known that the cinnabar anomaly of Mount Amiata (Italy) strongly influences the mercury content in the abiotic and biotic components of the ecosystem of the Northern Tyrrhenian Sea. (BALDI *et al.*, 1979; BARGHIGIANI *et al.*, 1991).

Hg analyses of several different species of marine organisms used for food from the area shown in Fig. 1 demonstrated a phenomenon of metal accumulation to concentrations often much higher than 0.7 µg g^{-1} fresh weight, the maximum limit accepted by the EC for the edible parts of marine organisms (BARGHIGIANI *et al.*, 1991).

The subject of this paper is the study of Hg concentration in muscle tissue of *Eledone cirrhosa*, a small octopus-like cephalopod. This is the most abundant cephalopod species in the Northern Tyrrhenian Sea, it is widespread in the Mediterranean Sea, and is also largely used as human food, with an average production of 100 t per year just by the Porto S. Stefano fishing fleet (DE RANIERI *et al.*, 1988).

The sampling of specimens was performed monthly by trawl surveys from March 1989 to August 1990 in the study area indicated in Fig. 1. Length, weight, sex and maturative stage were determined for each specimen. Hg analyses were performed on muscle tissue. Total Hg was determined by atomic absorption spectrometry on cold vapour before sample mineralization with nitric acid in a pressurized digestion system at 120 ° C f or 6 h .

From Fig. 2 it appears that *Eledone cirrhosa* accumulated high amounts of mercury which were correlated with the specimens size, notwithstanding the short life cycle of just two years (BELCARI *et al.*, 1990). It must be pointed out that many specimens had mercury contents over the EC limit. On the basis of the maturative stage it was possible to single out a single cohort and to follow it monthly during the whole life cycle; Fig. 3 reports the average monthly Hg concentrations related to the studied cohort throughout the life cycle. The analyses on males and females (Fig. 4) demonstrated that no statistically significant difference in mercury accumulation existed between the two sexes. The comparison with samples at the same maturative stage collected in the Ligurian Sea (Table 1), about 100 miles north of the study area, showed a greater Hg accumulation in our specimens which was statistically significant (t=6.582; p<0.001).

In conclusion, from our results it appears that this organism is a strong Hg concentrator and that a high consumption of specimens collected in contaminated areas such as the northern Tyrrhenian Sea could be dangerous for human health. Furthermore, due to its particular life cycle *Eledone* could be useful as a Hg biomonitor for evaluating environmental variations of the metal at different times. Indeed, according to what was observed by BELCARI *et al.* (1990), on the basis of the month of collection and the maturative stage, it is possible to evaluate approximately the age of the specimens.

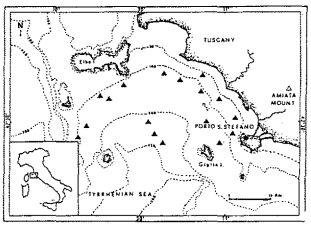

Fig. 1. Study area with sampling stations.

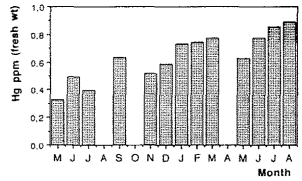

Fig. 3. Average monthly Hg concentration of samples of a single cohort.

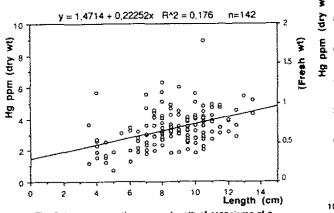

Fig. 2. Hg concentration versus length of organisms of a single cohort.

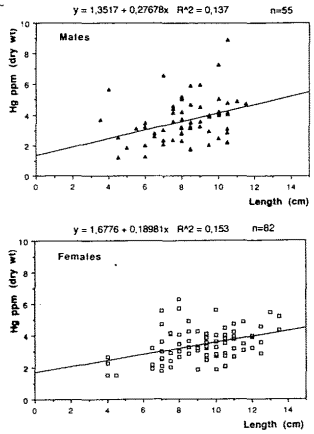

Fig. 4. Hg concentration versus organism length in males and females of a single cohort

Table 1 - Comparison with samples at the same maturative stage collected in the Ligurian sea.

	STUDY AREA	LIGURIAN SEA
No. of specimens	15	10
Length cm	6.5-9	8-10
Hg (ppm ± S.D. d.w.)	3.310±1.252	1.136±0.215

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Copper and Cadmium Levels in Fish from the Greek Waters (Aegean & Ionian Seas)

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Heavy metals are considered as the most important pollutants of the marine environment, due to their toxicity and their ability to be accumulated by the marine organisms. Although metal pollution in Greece is limited near the great industrial zones, the knowledge of the metal levels in marine organisms, especially in fish, is extremely useful. Fish muscle provides low metal content because of its low metabolic activity (CATSIKI et BEI, 1991). However it is very important to study the metal levels in this tissue in order to estimate metal quantities which enter to human by the fish consumption.

This work deals with Cu and Cd concentrations in fish species from the Aegean and Ionian sea and has been done within the framework of MED-POL Monitoring Program. Specimens of two categories of fishes : a) demersal, *M. barbatus* (size 15-16 cm), *M. surmuletus* (size 16-20 cm) and b) pelagic, *S. pilchardus* (size 14-16 cm), *B. boops* (size 16-20 cm) were collected during spring and autumn of 1989 from 5 greek marine areas of Aegean and Ionian sea : Alexandroupolis, Chios, Rhodes, Chania and Parga (Fig. 1). Ten specimens from each station were analysed. Individual samples from muscle tissue were prepared, lyophilised and digested with nitric acid under pressure and analyzed following the procedure described by CATSIKI *et al.*, (1991). The accuracy and precision of the methodology were tested during the UNEP Intercalibration Testing Exercise of 1984 and 1989. The data were statistically treated after log transformation log (x+1). In order to estimate if there are any differences among the sampling stations as well as among the two categories of fishes the two-way ANOVA was used (ZAR, 1984).

On the whole 131 samples were analyzed. Copper and cadmium concentrations, expressed in µg/g dry weight (ppm), are summarized in Table 1. Mean values of Cu ranged from 2.5 ppm to 3.37 ppm for demersal fish and from 2.74 ppm to 5.94 ppm for the pelagic fish. Mean Cd concentrations ranged from 0.64 ppm to 0.77 ppm for demersal fish and from 0.65 ppm to 0.78 ppm for pelagic fish (Table 1). The results of the present study are in agreement with levels in fish tissues reported from other Mediterranean regions (UNEP, 1986). Metal concentrations in the selected fish from this investigation did not show a great variability between the different regions, for both metals.

Statistical analysis showed that for Cu content Parga was significantly different (F= 12.192 p < 0.001) from all the other stations, especially as regards the accumulation of Cu from the pelagic samples (Fig 2) Cd concentrations showed that Alexandroupolis was different from the other stations having lower values (F = 9.818 p < 0.001) (Fig. 2).

The two categories of fish presented significant differences in metal accumulation (p<0.001 for Cu and Cd) observed at the interactions between station and category of fishes for both metals.

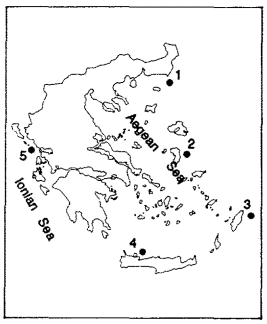

Figure 1. Location of Stations where samples have been taken.
1 = Alexandroupolis, 2 = Chios, 3 = Rhodes, 4 = Chania, 5 = Parga.

Generally pelagic fish exhibit higher concentrations of heavy metals, especially for Cu, mostly due to their ecology and physiology than other environmental factors (UNEP, 1986; KANETI *et al.*, 1987; CATSIKI & BEI, 1991).

TABLE 1

Fish Category			Cu				Cd			
	Station	N	avg	std	min	max	avg	std	min	max
DEMERSAL	Alexandroupolis	10	2.50	0.31	2.00	2.80	0.64	0.04	0.54	0.68
	Chios	20	2.47	0.86	1.20	4.15	0.72	0.09	0.54	0.97
	Rhodes	9	2.65	0.44	2.04	3.27	0.70	0.10	0.49	0.86
	Chania	13	3.37	0.55	2.60	4.40	0.73	0.09	0.60	0.88
	Parga	14	3.12	0.67	2.00	4.19	0.77	0.05	0.71	0.87
PELAGIC	Alexandroupolis	20	3.28	0.77	2.04	4.60	0.65	0.05	0.50	0.78
	Chios	10	4.44	1.20	3.20	7.45	0.78	0.07	0.66	0.88
	Rhodes	10	3.31	0.62	2.20	4.56	0.73	0.08	0.60	0.87
	Chania	16	2.74	0.63	1.98	4.20	0.67	0.03	0.60	0.76
	Parga	9	5.94	1.32	3.15	7.49	0.71	0.10	0.66	0.99

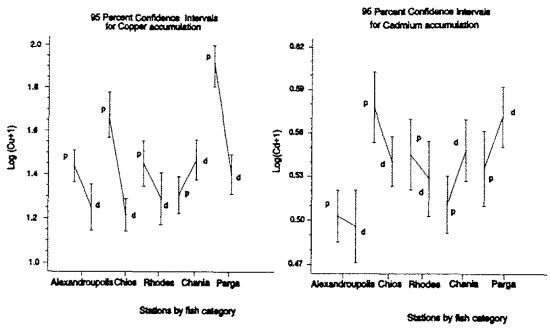

Figure 2. Mean values and 95% Confidence Intervals for Cu and Cd accumulation in the fish muscle from the five selected stations (p = pelagic, d = demersal).

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Les métaux lourds dans les sédiments des Côtes Occidentales d'Algérie

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La pollution des sédiments marins par les métaux lourds dans les côtes occidentales algériennes est peu connue. A ce titre nous avons réalisé une étude systématique en Mars 1990 pour déterminer le niveau de pollution des sédiments marins superficiels. La zone d'étude s'étend de la frontière algéro-marocaine jusqu'à Tenes (Figure 1).

Les échantillons ont été congelés dès leur prélèvement pour l'analyse des éléments: As, Cd, Cr, Cu, Pb et Zn. Ces échantillons ont subi un traitement et une analyse par spectrophotométrie d'absorption atomique selon les méthodes décrites par AMINOT et CHAUSSEPIED (1983) et UNEP/IAEA (1985 a, b, c, et d).

Les concentrations obtenues pour la plupart des métaux dosés ne présentent pas de valeurs très élevées. En moyenne, elles sont inférieures à celles observées dans les sédiments superficiels de la baie d'Alger (AOUAMEUR, 1990). Cependant nous avons observé des maxima excessivement élevés pour certains métaux tels que le Cadmium (Tableau 1).

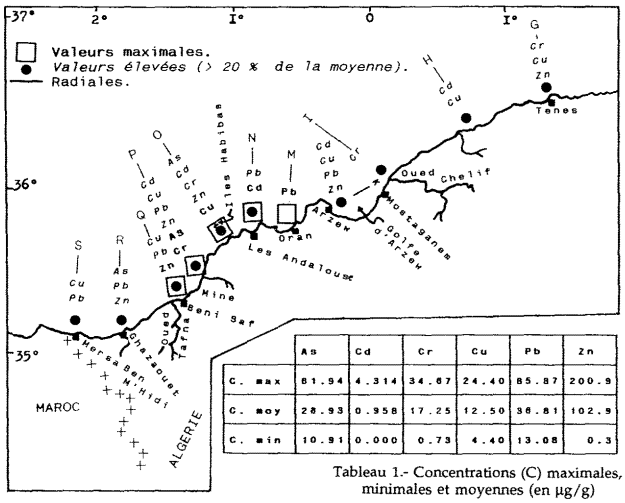
La distribution spatiale de ces résultats montre une bonne cohérence avec les conditions naturelles et anthropiques que subit la zone d'étude. Les valeurs maximales délimitent une région bien définie qui s'étend de Beni Saf jusqu'à Oran. Les valeurs élevées (> 20 % de la valeur moyenne) sont présentes dans toute la zone. Leur fréquence et leur coexistence varient d'un endroit à l'autre. La corrélation non significative trouvée entre les différents éléments à l'échelle du site évoque l'influence d'anomalies de pollution qui affectent le comportement et l'affinité géochimique des éléments.

Les radiales P et Q se trouvent à proximité de l'Oued Tafna, de Beni Saf et d'un gisement minier. Les rejets de l'exploitation minière ou les affleurements du gisement sont l'origine principale de cette pollution en métaux lourds dans cette zone. Dans la radiale 0, les valeurs élevées entre les îles Habibas et la côte peuvent être dues au tourisme très développé dans ce site. Elle peuvent évoquer aussi l'extension du gisement signalé (ou de sa pollution) vers l'Est ou bien la présence d'activités ignorées dans cette zone. La valeur maximale du cadmium, accompagnée d'une valeur élevée de plomb le long de la radiale N, suggère plutôt une pollution anthropique que l'influence d'une source naturelle. Les concentrations élevées de plomb le long des radiales M et N sont surtout le résultat de la pollution atmosphérique par les gaz d'échappement de voitures comme le montre GROUSSET (1989). Dans le Golfe d'Arzew, la zone industrielle est à l'origine des concentrations élevées de la radiale K.

Dans la partie Est de la zone d'étude deux valeurs sont remarquablement élevées. L'une du chrome qui se situe juste à l'embouchure de l'Oued Chelif et l'autre du cadmium et se trouve le long de la radiale H. Du côté Ouest, malgré l'importance de la pollution signalée dans la zone de Ghazaouet avec son industrie de zinc (SOUIKI, 1991), on n'observe pas de valeurs inquiétantes. Près de Ghazaouet, la concentration du zinc observée à 20 m de profondeur est de 148.1 µg/g (septième valeur de la zone étudiée).

Par comparaison à d'autres sites en Algérie on peut conclure que le site étudié ne présente pas une pollution alarmante. Cependant, la zone de Beni Saf - Golfe d'Arzew est une zone à risque de pollution. Il convient d'identifier et de surveiller les sources de pollution notamment pour cette zone et pour les valeurs très élevées de cadmium et de chrome observées le long des radiales H et I, respectivement.

Figure 1: Concentrations maximales et élevées des métaux analysés dans la zone étudiée



	As	Cd	Cr	Cu	Pb	Zn
C. max	81.94	4.314	34.67	24.40	85.87	200.9
C. moy	28.93	0.958	17.25	12.50	36.81	102.9
C. min	10.91	0.000	0.73	4.40	13.08	0.3

Tableau 1.- Concentrations (C) maximales, minimales et moyennes (en µg/g)

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Impact of a coastal disposal site for inert wastes on the physical marine environment : the Riva Ligure case

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The disposal of inert material derived from large civil engineering works together with the need to recover new areas of coast for tourism, port and related services has often lead to the choice of coarsal areas for waste disposal and thus to a series of ambiental problems.

In this work, the Riva Ligure (Imperia-Italy) waste disposal site is analysed for its impact on the underlying sediments and the surrounding water mass.

The disposal site is located between the mouth of the Argentina stream and the urban centre of Riva Ligure, at the centre of the physiografic unit bound to the west by Capo Verde promontory and to the east by Punta Santo Stefano. The material in the site comes almost exclusively from the digging of tunnels (Capo Negro and Santo Stefano) for the new Genoa-Ventimiglia railway line. Waste for a total volume of 126,000 m^3 were discharged into the sea between March 1988 and December 1989.

The dynamics of diffusion of the dumped material has been studied from the wave refraction and it is seen that the area of coast involved is mostly protected by the reigning wave motion (SW) but not against the less frequent but more violent Libeccio storms.

The study of coastal transport (CERC, 1973) has shown a general component north-eastwards but very low in comparison with the maxima found in the area. The HATTORI and KAWAMATA (1980) index-measuring method utilized for assessment of transversal transport has shown that waves incide orthogonally to the coast causing erosive phenomena but infrequently.

Analysis carried out on the water mass (temperature, salinity, density, nutrients, suspended matter) outlined three different patterns of coastal circulation (from north-west, east and south-west) depending on wind and sea conditions. The distribution of hydrological parameters (T, S, 6-t) has shown that thermal and haline variations depend not only on dispersion into the sea of freshwater but also on the mixing processes linked to the surrounding meteomarine conditions. The concentrations of nutrients are low and conditionated by the freshwater input. Within the nutrients, nitrites are absents or in very reduced concentrations. On the contrary, nitrates, silicates, ammonia and phosphates show highest concentrations near the mouth of Argentina stream (maximum values : 16.2 µmol/l, 35.5 µmol/l, 3.62 µmol/l, 0.29 ,µmol/l respectively). The concentrations of these latter nutrients decrease offshore (mean values: 0.3 µmol/l, 1.7 µmol/l, 0.6 µmol/l, 0.08 µmol/l respectively). The suspended particle distribution is also linked to fluvial inputs, to the nearness to or distance from the dump, and to wave action. The highest concentrations were found near the surface, close to the main stream outlets (2.5 mg/l on average) and to the dump area (5mg/l on average). The diffusion of the suspended particles seems to be related to different pressure regimes which determine the concentration and dispersion of the particles within the surface layer (above 5 m depth). Since the prevailing winds in the zone are from the first quadrant, on average the dispersion is to the SW. Except for the stations near the tidal zone, suspended particle concentrations are generally low throughout the column (0.4 mg/1) .

The textural distribution of sediments and the analysis of granulometric data highlight the progression of sands over pelitic sands, besides confirming the general dispersion of mobile bottom sediments eastwards. Moreover, the presence of areas of accumulation near the dump characterised by a higher level of pelite than the surrounding sediments is to be noted. This phenomen is due to the gradual effects of wave motion on the front of the waste disposal site and to the release of fine materials deriving from movement and dumping operations in the waste deposit. In particular, it was noted that material of medium and coarse sand dimensions tends to move in a direction subparallel to the coast as far as the 4 m isobath, whereas fine and very fine sand moves between the 4 and 15 m isobaths. Thus, one can say that the waste deposit contributes to the mobile bottom sediments supplying material of different granulometry. The coarser part of this material forms a layer in shallow waters, while very thin sand and pelite partly deposit close to the waste dump and partly move to the open sea settling at greater depths (to the 15 m isobath and beyond) mixing perfectly with the natural river and sea sediments present there.

Mineralogic, petrographic and geochemical analyses, carried out to distinguish material of the dump from sea and river sediments, generally confirmed the remarkably homogeneous composition.

Studies on the benthic population carried out during dumping operations highlighted the presence of biocoenoses typical of fine sediments in the waste disposal area. However, the proximity of the mouth of Argentina stream does not allow to distinguish the effect due to the waste disposal from that due to the stream itself (RELINI, pers.comm).

The results of the present study lead to the conclusion that the dump being examined does not substantially alter the mineralogic-granulometric parameters of the sea bottom and physico-chemical parameters of the surrounding water mass. Only during the rare sea floods is the exposed front of the dump eroded, with the consequent transfer of heterogeneous material into the sea. The particular geographical position of the dump within the physiographic unit and the coastal dynamics in this part of the sea suggest that, at the end of the discharge process, material from the waste deposit will rapidly become incorporated into the natural sediments.

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Processus de décontamination de sédiments pollués par le Cu : étude expérimentale *in situ*

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Les sédiments sont en quelque sorte les "archives" de l'histoire d'une région côtière car ils reflètent de manière fidèle la qualité de l'environment. Ce travail a eu comme objectif l'étude de la possibilité de décontamination des sédiments pollués, transférés vers un site non pollué, après leur mise en modules expérimentaux (ARNOUX *et al.*, 1985). Du sédiment autochtone (non "pollué") était également mis en modules, en vue d'effectuer des comparaisons.

La contenance en cuivre des sédiments des modules ainsi que celle des sédiment libre était surveillé pendant l'expérience qui dura 19 mois. Le cuivre (Cu) était déterminé sur la phase solide des sédiments (provenant de trois profondeurs des modules: 0-2cm, 2-4cm, 4-8cm) par la méthode de spectrophotométrie d'absorption atomique avec flamme et sur la phase liquide (obtenue par centrifugation de la partie restante des sédiments de chaque module) par D.P.A.S.V. (Differential Pulse Anodic Stripping Voltammetry) (NUMBERG, 1984), tout le processus étant effectué sous hotte à flux laminaire, (pression positive, classe 100), dans un laboratoire spécial, à "poussière limitée" (MART L., 1982) .

En tout 413 échantillons de la phase solide et 75 de la phase liquide ont été analysés. L'évolution temporelle de leur contenance métallique moyenne est reportée sur les Fig. 1 &2.

Les sédiments provenant du site pollué contenaient au départ de l'expérience en moyenne 57.8 µg/g de Cu dans la phase solide et 1177.10 ng/l dans la phase liquide. Le site de transplantation, nettement moins contaminé contenait 22.4 µg/g et 466.40 ng/l de Cu respectivement.

Durant le premier mois de l'expérience on remarque une chute spectaculaire des concentrations métalliques dans les modules des sédiments "pollués" (Figures 1 & 2); de l'ordre de 15 µg/g de Cu dans la phase solide et 757 ng/l dans la phase liquide. Cette décontamination métallique au bout d'un mois s'élève au 25 % de la contenance initiale en Cu des sédiments "pollués". La suite de l'expérience est caractérisée par de légères fluctuations de la concentration du cuivre ; attribuées à l'équilibre dynamique entre la phase liquide et la phase solide (BOULEGUE, 1981). A la fin de l'expérience les taux du cuivre dans les modules "pollués" approchent ceux des modules "non pollués" qui contiennent les sédiments du site de transplantation. Plus spécialement, après 19 mois de séjour au site de transplantation les sédiments "pollués" ont perdu le 47 % du Cu de la phase solide et le 70.74% du Cu de la phase liquide. La perte métallique était lente mais toutefois progressive.

L'analyse statistique confirme que la variation des métaux durant l'expérience est statistiquement importante dans tous les types de sédiments. L'analyse de covariance a démontré que le cuivre variait en même temps et vers la même direction dans les différentes profondeurs des modules. Par contre il n'y a pas de covariance entre les modules "pollués" et "non pollués". Les différences entre la contenance métallique des trois profondeurs d'échantillonnage des sédiments "pollués" étaient également significatives statistiquement : le sédiment présentait un gradient positif de concentration de la surface vers le fond ; ce qui montre que la "décontamination" des sédiments commence par la superficie et avance progressivement vers le fond. Un facteur jouant un rôle important sur ce phénomène est le remaniement des sédiments par les organismes (STORA, 1984) ; ce qui fait remonter à la surface des modules, les sédiments du fond.

Figure 1
Evolution du Cu dans la phase solide

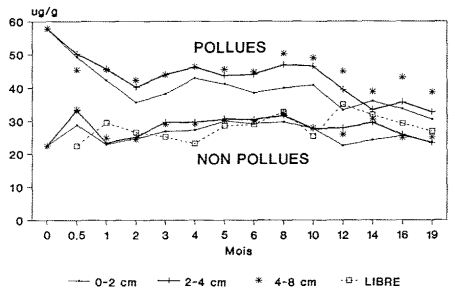
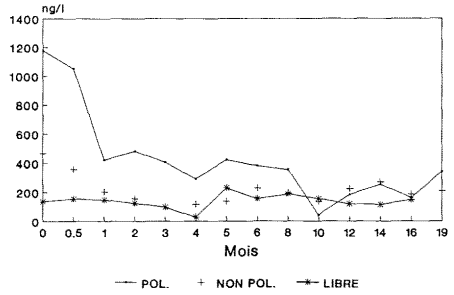


Figure 2
Evolution du Cu dans la phase liquide



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Dosage des métaux lourds Fe, Zn, Pb, Cu, Cd et Hg chez l'Espadon *Xiphias gladius* L. pêché en Algérie

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Les gros pélagiques, situés en fin de chaîne trophique, sont considérés comme des bioaccumulateurs de métaux lourds. Dans ce groupe, l'espadon *Xiphias gladius* L. a fait l'objet de dosages en fer Fe, zinc Zn, plomb Pb, cuivre Cu, Cadmium Cd et mercure Hg.

Deux méthodes d'analyse ont été retenues, basées sur le même principe d'excitation des atomes dont les électrons en se déplaçant, émettent un rayonnement X caractéristique, proportionnel aux concentrations recherchées. Les deux techniques font appel à des programmes informatiques de traitement des intensités relatives mesurées. La première, intitulée "PIXE" (Particule Induced X-ray Emission) utilise le modèle "D-PIXE" (BENAMAR *et coll.*, 1990) alors que la seconde, "X-RF" utilise "AXIL" (VAN ESPEN *et coll.*, 1976).

L'étude a porté sur trois tissus, le muscle, le foi et la gonade. Les individus ont été échantillonnés par classe de poids de 10 Kg jusqu'à 40 Kg puis de 20 Kg pour les plus gros, soit des centres de classe respectifs de 15, 25, 35, 50 et 70 Kg. La similitude des résultats obtenus par les deux méthodes a conduit à calculer une valeur moyenne pour chaque élément dosé dont les concentrations en ppm (partie par million) sont fournies dans le tableau suivant:

Organe	Elément	Poids (kg) 15	25	35	50	70
MUSCLE	Fe	6.5 ppm	98.66 ppm	133.1 ppm	135.72ppm	81.82ppm
	Cu	4.14 "	5.1 "	4.73 "	4.95 "	5.28 "
	Zn	24.1 "	36.66 "	56.44 "	108.73 "	193.46 "
	Pb	2.6 "	3.14 "	4.86 "	3.2 "	6 "
	Hg	0.028 "	0.038 "	0.031"	--	0.032"
GONADE	Fe	70 ppm	61.09 ppm	33.33ppm	71.40ppm	90.89ppm
	Cu	4.48 "	5.16 "	5.78 "	5.88 "	5.52 "
	Zn	288.97 "	293.45 "	366 "	350.20 "	485.12 "
	Pb	4.01 "	3 "	2.70 "	2.38 "	2.89 "
	Hg	0.085 "	0.029 "	0.033"	0.046"	--
FOIE	Fe	242 ppm	337.55 ppm	524.39ppm	571 ppm	424.76ppm
	Cu	5.31 "	5.64 "	5.78 "	6.42 "	7.38 "
	Zn	50.78 "	62.66 "	84.87 "	80.50 "	73.33 "
	Pb	3.99 "	3.88 "	4.12 "	5.42 "	6.42 "
	Hg	0.029"	0.057 "	0.14 "	0.07 "	0.088"

Nota: le cadmium, à l'état de trace n'est pas indiqué, sa très faible charge le situe hors de la calibration adoptée.

Les taux en différents métaux montrent une accumulation sélective selon l'organe considéré. Le fer s'accumule préférentiellement dans le foie et le zinc dans la gonade. La bioaccumulation semble vérifiée pour quasi-tous les éléments dans le muscle. Certaines valeurs ne correspondent pas systématiquement au concept théorique de l'accumulation en raison d'une variabilité individuelle conséquente qui se manifeste dans les effectifs assez réduits dans certaines classes de poids.

Les taux, variables selon les organes, évoquent des mécanismes de régulation différentielle liés à la physiologie du tissu et à la rémanence du métal.

Les résultats, exprimés en poids frais, indiquent que les teneurs estimées, pour le mercure notamment, sont très inférieurs aux normes F.A.O. de l'ordre de 0.5 ppm. Ainsi, les espadons capturés à Ghazaouet répondent aux exigences en matière de pollution par les métaux lourds. Les valeurs élevées de zinc seraient éventuellement dues à l'activité d'une usine d'électrolyse déversant des quantités importantes de ce métal. Cependant, les gros pélagiques auxquels appartient l'espadon, poissons migrateurs par excellence, ne séjournent pas longtemps dans une même zone; la question est de savoir à présent la durée du mécanisme de bioaccumulation.

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Trace metals and the marine Bivalve *Venus verrucosa* : détection in the gills, using secondary ion mass spectrometry (SIMS)

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Mediterranean waters are exposed to pollution by trace metals. Mussels and other bivalves readily accumulate toxicants in their tissues which reflect ambient levels of contaminants. The Mussel *Mytilus edulis* is widely used in pollution monitoring programs (e.g."Mussel Watch"). But when this species is not found in a given area, such as Malta, it is necessary to evaluate the possibility of considering another bivalve as an indicator species. The scope of the present paper was to investigate a sublittoral species,*Venus verrucosa* (Mollusca: Bivalvia), already studied concerning accumulation of petroleum hydrocarbons (1).

Animals were collected by divers from coastal waters of Malta. Gill which is the main exchange organ, was investigated using SIMS, which enables the détection and visualization of elements on histological sections (Fig.1), with a high sensitivity (2). Low mass and high mass resolution spectra (to make the distinction between mono and polyatomic ions) were obtained, indicating the presence of fluorine 19, aluminium 27, sulfur 32, iron 56 (Fig. 2 & 3), copper 63, bromine 81, silver 107 (Fig. 4 & 5), and the rare earth elements : lanthanum 139 and thulium 169.

These preliminary data have to be followed by further investigations on other tissues of *V.verrucosa*, using SIMS and the Electron Microprobe (EMP) which allows elemental détection at the ultrastructural level.

From our present data, it appears that *Venus verrucosa* could be used as sentinel organism for monitoring trace metal pollution and, moreover, may be of ecological significance in those Mediterranean coastal zones characterised by relatively low productivity.

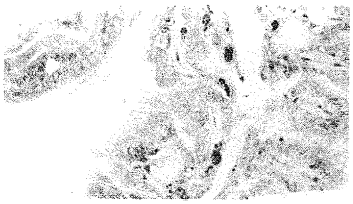

Fig.1. Venus verrucosa, gill. Photon micrograph of semithin section of filament showing epithelial cells with cilia. X 800.

Fig.2. Venus verrucosa, $^{40}Ca^{+}$ ion image showing the topography of the section with gill filaments. X 800.

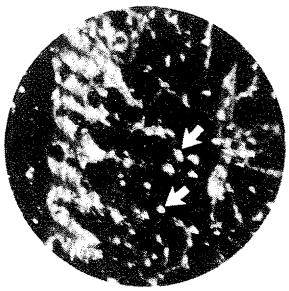

Fig.3. Venus verrucosa, $^{56}Fe^{+}$ ion image obtained from the same area as Fig.2, showing high iron emission from numerous white points of epithelial cells (arrows), X 800.

Fig.4. Venus verrucosa, $^{40}Ca^{+}$ ion image showing the topography of the section with gill filaments. X 800.

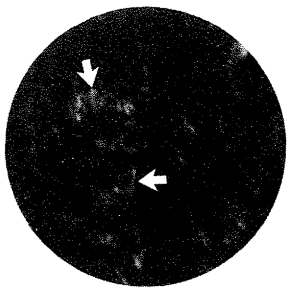

Fig.5. Venus verrucosa, $^{107}Ag^{+}$ ion image obtained from the same area as Fig.4, showing silver emission from white areas of epithelial cells (arrows), X 800.

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In situ toxicity of oil and dispersants in phytoplankton communities

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Most ecotoxicological studies quantify the effects of oil dispersants performing an analogous test with individual species in the laboratory. The extrapolation of the results from the laboratory to the actual field situation is often based on misleading results. This study, taking into account the model of a coastal ecosystem, evaluates the effects of oil and oil dispersants on phytoplankton at *in situ* conditions.

The experiment took place in June 1990 in a coastal area of East Saronikos Gulf. Three plastic enclosures (3.5m-depth X 1.2m-diameter), one with control (C1), one with oil (Arabian light- 500ml) (C2) and one with oil added dispersant (Arabian light 500 ml + BP lIOOX at a ratio l:lO)(C3) were used. The experiment was based on the general idea of KUIPER (1984). Sampling was done every other day. Analysis of phytoplankton and chlorophyll determinations were made while diversity and dominance indices were calculated; the concentration of oil in each sample was also determined. Univariate analysis, descriptive plotting and multivariate (MDS) analysis was used.

The salinity was almost constant while the temperature ranged from 20.9 to 22.3 °C. The oxygen measurements on selected days showed that the concentration was always near the saturation level. The total oil in water concentrations in the three enclosures ranged from 0.02 to 0.12 in C1, 3.8 to 6.1 in C2 and 64.0 to 24.5 (ppm) in C3, always descending with time. The differences in the oil concentration could be attributed to the fact that C1 is the control, in C2 the oil remained only in the surface, while in C3 the oil has been distributed in the whole water column. Chlorophyll-a ranged between 0.144 µgr/lt (C2, 13-6-90) and 0.588 µgr/lt (environment, 15-6-90). Chlorophyll-b and Chlorophyll-c values fluctuated proportionally to those of chlorophyll-a. The pigment index in polluted enclosures showed some extremely high values ranging from 1.33 to 23.91 in the C2 and from 1.44 to 83.41, in the C3. The analysis of variance of chlorophyll-a values for the four series of samples (Environment,Cl,C2, C3) showed that not significant difference occurs between the control, polluted and environment samples.

Diversity indices ranged from 0 (C3, 13/6/90) to 3.096 (C1, 20/6/90) while dominance value ranged from 41.55 (Environment, 9/6/90) to 100 (C3, 13/6/90, 22/6/90). The very high/low dominance/ diversity values were due to a coccolithophore bloom (*Coccolithophore* sp.) and it should be attributed to the pollution effects in combination with the environmental factors and the prevailing winds.

Phytoplankton abundance fluctuated in a wide range from some thousands (2,8x103 cells/lt) to some millions (12,4x106 cells/lt). The phytoplankton cells in C1 were decreasing with time, which is characteristic of a confined population. The decrease of the number of species observed in C3was more pronounced than in C2 and C1. In C1 *Clyptomonas* sp., *Gymnodinium* spp. and *Flagellates* spp. were the dominant species.

The k-dominance curves revealed the instability of this coastal ecosystem (CHRISTAKI, 1990; CHRISTOU, 1991) and showed that C3 is dominated by one species; two days later a considerable decrease of species number was observed in C2 while the situation in C3 remained the same (Fig. 1).

Chlorophyll-a values in C2 and C3, fluctuated in a quite narrow range (from 0.1 to 0.58 µgr/lt), which suggests that heterotrophic forms (nanoflagellates, bacteria) apparently dominated the population and could be attributed to the duration of the experiment. The above observation is more pronounced in the case of C3, when cell concentrations of $12X10^{6}$ cells/l gave relatively low (0.365 µg/lit) chlorophyll-a values. The pigment index in polluted enclosures showed some extremely high values which can be attributed to the presence of oil in the samples in connection to the species poor to chlorophyll-a.

Phytoplankton diversity and species composition changed, in oil mesocosms immediately after the start of oil additions; an increase of temperature in the North Sea caused also a parallel increase of phytoplankton biomass (ELMGREN *et al.*, 1980). It should be mentioned, however, that relevant experiments in the North Sea and the Baltic may give differentiated results. This is expected since different environmental factors exist between northern and southern European seas. Finally visual observations after treatment of the oil with dispersant showed that turbulence was the key factor in the dispersion procedure. Thus, the oil and the mixture of oil+dispersant had an effect on phytoplankton communities and the most interesting feature of phytoplankton succession in the enclosures was the shifting of the population towards monospecific blooms which was evident and was more pronounced in the oil+ dispersant mixture.

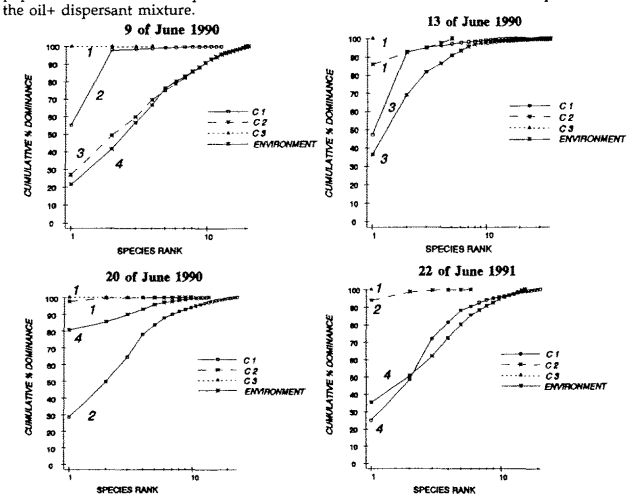

Figure 1 K-dominance curves including the species dominance. 1-*Coccolithus* sp. 2-*Gymnodinium* sp., 3=*Flagellates* sp., 4=*Cryptomonas* sp.

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Seasonal variation of some heavy metals in the zooplancton of Izmir Bay

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At the first step in the trophic level of marine environment planktonic organisms absorbe pollutants, coming in to the environment from different sources, by being suspended in the medium and by having wide total surface. Directly or indirectly accumulated dissolved materials were then transfered to the human body through food chain as the plankton being pray to the carnivorus organisms (UYSAL,1975).

Some heavy metals are well-known to be a treat for human life which may consequently be a cause of death (ENGEL *et al.*, 1981; COOPER, 1980; I.R.P.T.C.,1980; MEDINA *et al.*, 1988).

Therefore it had been decided to determine the levels of pollutants accumulated in zooplankton. The samples were collected from 9 stations where the areas effected by domestic and industrial discharges (UYSAL and TUNCER, 1982), in Izmir Bay, by means of plankton nets of 0.5 m diameter and 200 µm mesh-size (Fig.l). All samples dominatly contain Copepods, Cladocerance, obtained in throughout 1989 had been analysed for the Hg_t and Cd by using "Atomic Absorption flame spectrophotometer Varian Techtron Model 1250" and calculated as $\mu g.g^{-1}$ wet weight basis (BERNHARD, 1976; UYSAL and TUNCER, 1982).

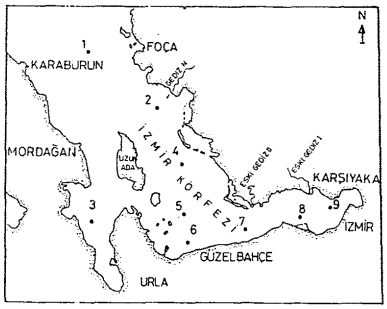

Figure 1. Sampling stations

According to the results of the analysis, it can be seen some changes from Table 1. Hg_t concentration varied between 0.012 and 1.896 $\mu g.Hg_t g^{-1}$ and Cd concentration varied between 0.054 and 16.790 $\mu g.Cd g^{-1}$. As a result of accumulation levels in these metals, it has been found out that Cd>Hg.

In general, heavy metal concentrations in marine organisms are tending to increase during summer period. Also, considerably high heavy metal concentrations of zooplanktonik organisms during summer period was possibly due to the increased metabolic activity of these organism. As conclusion; it has been necessary to determine the accumulated levels in planktonic organisms because of their importance as first step marine food chain organisms longing up to the human being continuously and periodically.

Table 1. Cd and Hg concentrations of zooplancton samples collected from Izmir Bay.

Sta.	Metal	Winter	Spring	Summer	Autumn
1	Hg	-	0.646	1.896	0.235
	Cd	-	0.984	0.214	0.790
2	Hg	0.106	-	0.207	0.024
	Cd	0.271	-	0.237	0.622
3	Hg	0.366	1.105	0.721	0.089
	Cd	0.419	4.210	0.329	0.245
4	Hg	0.272	0.078	0.630	0.035
	Cd	0.484	0.158	0.320	0.265
5	Hg	-	0.195	0.440	0.035
	Cd	-	0.248	16.790	0.336
6	Hg	0.080	0.071	0.239	0.121
	Cd	0.122	0.180	0.182	0.278
7	Hg	0.105	0.052	0.213	0.012
	Cd	0.160	0.411	0.054	0.077
8	Hg	0.140	0.082	0.229	0.066
	Cd	0.106	0.126	0.174	0.416
9	Hg	0.140	0.065	0.538	0.022
	Cd	0.106	0.049	0.205	0.071

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Seasonal changes in faecal indicators distribution in Northernmost part of the Adriatic Sea

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Coastal contamination by wastes in the northernmost part of the Adriatic Sea is described by using multivariate analysis on microbiological indexes.

Coastal contamination is of particular interest because it is the result of waste discharges from both industrial and domestic sources. The polluting agents are of physical, chemical or biological nature. In order to establish the influence of the wastes, treated or untreated, on the coastal seawater of the Northern Adriatic Sea, the microbiological quality of the water was evaluated by analysis of faecal pollution's indicators.

Seasonally, from January 1991 to December 1991, a monitoring program was carried out in 28 stations, located at 200m (st. 0), 500m (st.1), 1000m (st.2) and 3000m (st.3) offshore, in the Gulf of Trieste stretching from the mouth of the River Tagliamento to the Bay of Muggia (Fig. 1).

Water samples were analyzed for Total Coliforms, Faecal Coliforms and Faecal Streptococci by the multiple tube technique (Standard Methods, 1989). Simultaneously in every station, physical - chemical parameters were determined by the multiprobe 401 Idronaut.

For classifing the stations on the basis of faecal pollution's indicators a cluster analysis, multivariate analysis method, was carried out (LAGONEGRO and FEOLI, 1985). The correlation coefficient among faecal pollution indicators was also calculated (Tab.1).

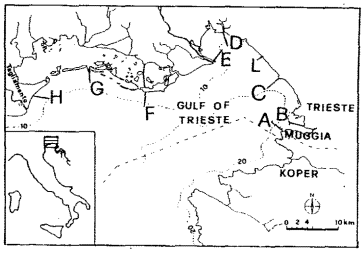

Fig. 1 : Map of the stations

Tab. 1: Correlation coefficient among faecal pollution indicators.

	MARCH			JUNE			SEPTEMBER			DECEMBER		
	TC	FC	FS	TC	FC	FS	TC	FC	FS	TC	FC	FS
TC	1.00	0.83	0.48	1.00	1.00	0.20	1.00	1.00	0.21	1.00	0.41	0.44
FC		1.00	0.51		1.00	0.20		1.00	0.21		1.00	0.84
FS			1.00			1.00			1.00			1.00

TC = Total Coliforms FC = Faecal Coliforms FS = Faecal Streptococci

degree of freedom = 26 significance level = 0.01 R = 0.4736

In summer (June) and in autumn (September) similar distribution of faecal indicators was observed and it revealed mostly urban pollution. In fact, the stations influenced by urban wastes are connected among each other (Fig. 2: group 1.1.1). Water column stratification in this periods probably does not allow the faecal input to dilute. It remains confined to the surface.

Spring (March) and winter (December) cruises show different situations. In March some stations seems to be affected by fresh water inputs, whereas other stations suffer urban wastes. Homogeneous conditions of the water column during the winter cruise (December) helped to dilute both river and urban inputs. Probably, for this reason, most of the stations are placed in the same group (Fig. 3 : group 1 . 1 . 2).

Some seasonal differences have been observed also considering the correlation coefficient between pollution indicators. In June and September the correlation coefficient was highly significant only between Coliforms, while in March and December highly significant values were calculated between Coliforms and Streptococci (Tab. 1).

The method used to analyse distribution of faecal indicators seems to give correct informations about the real pollution conditions of the investigated area.

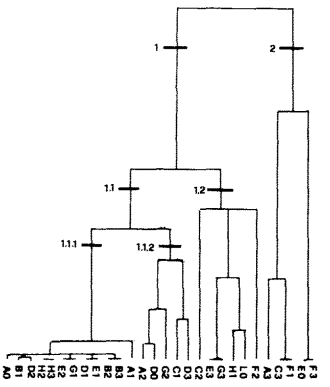

Fig. 2 : classification of the stations in the summer cruise.

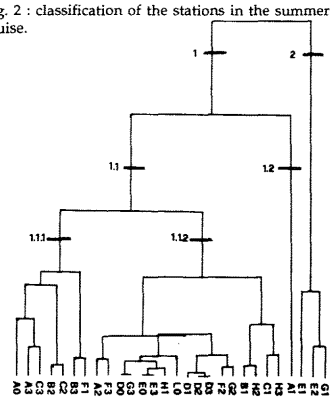

Fig. 3 : Classification of the stations in the winter cruise.

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Choix de paramètres bio-géochimiques globaux qui permettent une évaluation directe de la qualité des sédiments

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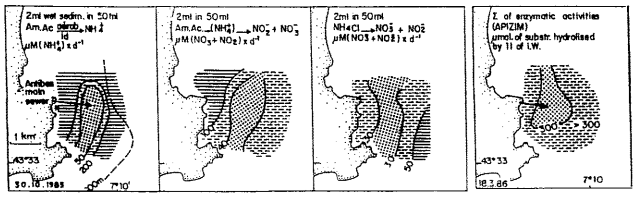
Pendant plusieurs années les travaux de recherches relalifs à la pollulion des sédiments marins ont eu pour principal but de repérer la présence de polluants et d'en mesurer les concentrations. Par exemple, des mesures de concentrations en détergents ou en métaux lourds tels le Hg, le Cd el le Pb ont été réalisées. La répartition cartographique de ces polluants a fréquemment permis de localiser des sources de pollution (voir par ex. DE LEON *et al.*, 1983, VOUTSINOU-TALIADOURI, 1983; VARNAVAS *et al.*, 1985).

Cependant on conçoit que la démarche qui consiste à mesurer seulement des concentrations globales ne fournit que des renseignements limités. Une des critiques qui a été formulée est que les polluants ne s'accumulent pas nécessairement au voisinage du point de rejet; il arrive fréquemment qu'ils s'accumulent assez loin de tels points (EVENS *et al*, 1986; DAMIANI *et al.*, 1986). Le taux d'accumulation de sédiments jouerait un rôle: les polluants seraient plus concentrés dans les secteurs à fort taux de sédimentation. Un autre reproche qui peut être fait à la méthode qui consiste seulement à mesurer les concentrations globales en polluants est que les résultats obtenus ne permettent pas de déterminer à quel point les polluants présents dans les sédiments sont susceptibles d'altérer la vie benthique, ou s'ils sont stockés. On peut aussi faire remarquer que la qualilé des fonds marins (ou leur état de santé) n'est pas convenablement définie par les seules mesures des concentrations: il n'est en effet pas évident que des polluants piégés dans les sédiments aient systématiquement un impact sur la vie benthique.

CARTOGRAPHIE : SEDIMENT GLOBAL EAUX INTERSTITIELLES



Propriétés des sédiments autour de l'émissaire d'Antibes (80000 habitants) a) Quantité d'ammoniaque produit en 1 jour d'incubation par 2 ml de sédiment frais mélangés à 50 ml d'une solution riche en acides aminés. b) Transformation en nitrate. a+b = potentialité ammonifiante. c) Transformation d'ammoniaque en nitrite + nitrate. d) Somme des activités des exo-enzymes hydrolases déterminées par la méthode APIZYM (19 substrats hydrolysés par 65 ul d'eaux interstitielles; les 19 substrats appartiennent aux groupes des acides aminés, protéines, carbohydrates, lipides, acides gras et phosphore organique). Les potentialités sont d'autant plus fortes que l'on s'éloigne du point de rejet au voisinage duquel la teneur en matière organique est pourtant plus élevée.

Pour compléter l'information, plusieurs types de démarches ont été adoptés. Par exemple les données géochimiques sont confrontées les unes aux autres et à des paramètres purement sédimentologiques (granulométrie ou minéralogie des argiles) à l'aide de traitements statistiques (corrélations, analyses factorielles) (voir par ex. RINGOT, 1983; OBIOLS SALVA *et al.*, 1985). Des estimations des flux à l'interface ont aussi été faites (voir par ex. EL-SAMRA *et al.*, 1985; FERNEX *et al.*, 1986).

Nous voulons montrer ici que certains types d'analyses géochimiques sont susceptibles de conduire directement à une évaluation de l'état de santé des fonds marins (indépendemment des études qui pourraient être faites sur les organismes qui vivent sur le fond). Dans ce sens, nous avons retenu un certain nombre de paramètres globaux: le taux d'ammonification dans le sédiment (qui correspond au taux de minéralisation de l'azote organique), les activités enzymatiques globales du sédiment : ammonifiantes, nitrifiantes, dénitrifiantes, (capacité qu'un sédiment a d'agir sur un substrat spécifique; BRISOU, 1985), évaluation des activités des exoenzymes présents dans les eaux interstitielles (méthode "Apizym"; MONGET, 1978), la capacité complexante des eaux interstitielles ou, mieux, la capacité complexante rapportée à la quantité de matière organique dissoute. Les méthodes et techniques pour mesurer ces paramètres ont été exposées dans BENAMOU *et al.*, (1989), BENAIM (1990), FERNEX *el al.* (1992), etc. Certes, la signification des résultats obtenus mériterait d'être précisée. Néanmoins la cartographie des fonds de quelques sites du plateau continental devant la Côte d'Azur a permis de distinguer des zones où les sédiments, pauvres en matière organique, ont néanmoins des potentialités enzymatiques élevées, des secteurs riches en matière organique avec des activités et des potentialités enzymatiques élevées (devant l'embouchure des fleuves), et des secteurs où les sédiments sont riches en matière organique mais ont des activités et des polentialités faibles (au voisinage de points de rejets d'eaux usées).

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Changes in the sediment and water column due to fish farming in a Mediterranean Bay (Fornells, Balearic Islands)

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The Bay of Fornells is a restricted bay in the North of Menorca Island. Its area is 4.1 km^2 and its maximum dimensions are 4.73 km north-south and 1.5 km east-west. The average depth is 5.5 m with a maximum of 20 m near the outlet. Strong and frequent north winds determine the hydrodynamics of the bay as evidenced by the sediment distribution (FORNOS *et al.*, 1992).

The activity of fish-farms produces an input of organic waste from the uneaten food and faeces, a concentration of animal life in the zone and a reduction in solar radiation. This activity causes changes in water quality mainly in closed bays. In Fornells Bay fish culture started in 1985 and has been increasing ever since. During the study period, 32 cages were installed, each of 100 m^3 containing *Sparus auratus* (L.) with an input of 77 Tm of dry fodder per year. This implies the beginning of a eutrophication process.

Three hydrological sample stations were placed in the axis N-S and monitored every two months from January 1991 to January 1992 : E-1, (5 m depth) in the interior of the bay; E-2, (7 m depth) in the middle of the fish farm; E-3, (20 m depth) near the outlet. The sedimentological study was made by means of four transects extending from the centre of the cages to the unaltered zone. Sediment traps (FORNOS *et al.*, 1989-90) were also installed under the cages and beyond the fish farm (control traps) to estimate the discharge of particulate matter. These two studies were monitored during the summers from 1988-92.

The hydrological study shows few changes for the first 5 metres among the sample stations. Average values of the year are :

	E- 1	E-2	E-3
Oxygen. %:	93.35	92.45	95.80
Temp. °C:	18.01	18.14	18.46
Chl-a. mg.m^{-3}	0.376	0.445	0.377
Light ext. %	32.63	37.93	46.63

The physico-chemistry of the sediments under the cages shows the following values : 40-60% carbonate (CO_2 gasometry), 7-18% volatile solids (calcination at 450°C for 2h), 1.5-5% organic carbon (GAUDETE *et al.*, 1974) and 0.2-0.4% nitrogen (Kjeldahl), 33.5-60% sand, 11.8% fine sand, 23.7% silt, 17.1% clay (HEAD, 1984).

There is an increase in the average particle size under the cages. This explains the increase in carbonate composition of the sediment, as the sand fraction is principally composed of bioclastic remains, mainly *Halimeda tuna* (Ellis & Solander) Lamouroux segments. At the same time benthic communities disappear (ZABALA *et al.*, 1992) and so can no longer trap and bind the fine material. Thus current and wave action clean the area surrounding the cages.

The effects of the fish farm to the sediments are not confined to the area around the cages but also affect the whole bay. They are particularly noticeable in the shallow interior area where the hydrodynamics are low with a consequent accumulation of fine materials (FORNOS *et al.*, 1992) and only there is a located increase of phytoplankton biomass surrounding the cages.

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Striped Venus (*Chamelea gallina*) in Neretva Estuary - Biological Evaluation and Estimation of Petroleum and Chlorinated Hydrocarbons

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Edible shellfish Striped venus (*Chamelea gallina)* in great abundance inhabits the alluvial sands along the Italian (Adriatic) coast and makes an extensive fishable resource over which today about 700 fishing vessels (hydraulic dredges) FROGLIA (1989) produce yearly about 100.000 tons.

Thanks to the fisheries experience gained along the Italian coast it is for the first time in the estuary of Neretva river discovered fairly abundant bank (0.5 km^2) of Striped venus population of the (Fig. 1) standing stock size and annual yield of 100 tons for only two fishing boats.

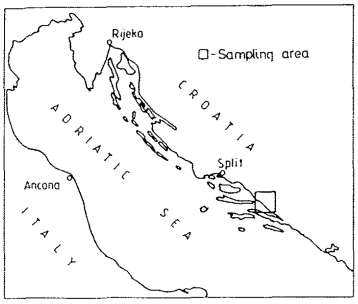

Fig. 1. Area of investigation - Neretva estuary

Since the habitat of this benthic community is exposed to the Neretva river various organic discharges, either directly by river inflow or by agriculture activities, a sanitary control and evaluation of organic pollutants concentration accumulated in species tissue for marketing purposes has been performed.

Idioecological characteristics of the species in the western Adriatic are described by POGGIANI *et al.*, (1973) while the biometric, i.e. length frequency distribution of the species in the Neretva river estuary is presented on the Fig. 2.

The presence of chlorinated hydrocarbons was also established in the shellfish tissue (hexachlorobenzene, heptachlor, aldrin, DDT and its metabolites and lindan. Found values range from 1.4 ng/g of tissue dry weight for lindan to 10.0 ng/g for ppDDT. (Fig. 3). For some compounds these values exceed the limits permitted by the Book of regulations for foodstuffs. The values recorded for DDD were exceptionally high (1050 ng/g). Policyclic aromatic hydrocarbons are the second type of found organic pollutants. Their proportion makes up 2.2 µg chrysene equivalents per g of dry weight that is 26.1µg ROPME oil per gram of dry weight. The characteristic emission spectra of I and II aromatic fractions is presented in Fig. 4, where the benzopyrene peak is evident as well as the aromatic compounds with 2-4 rings (oil source).

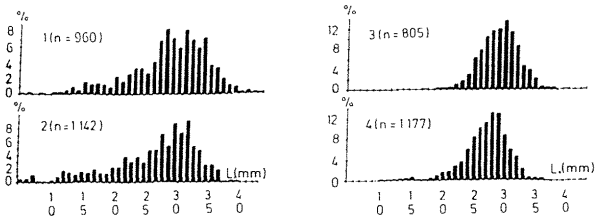

Fig. 2. Length frequency distribution of the Striped venus in the Neretva estuary (December 1990)

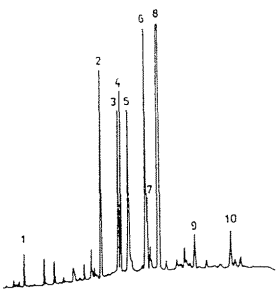

Fig. 3. EC capillary chromatogram of the F_2 fraction of shellfish in the Neretva estuary (December 1990). Numbered peaks belongs to following compounds: 1-lindane; 8-DDD; 9-DDT; 2-7 and 10-unknown

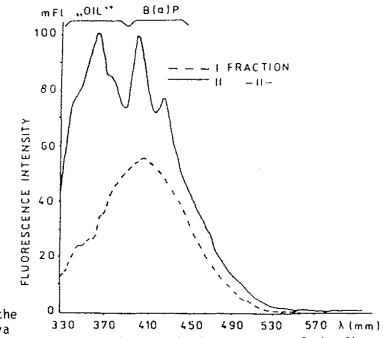

Fig. 4. Continuos emission spectra of the first (I) and second (II) fraction of shellfish in the Neretva estuary (December 1990)

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Chlorinated hydrocarbons in a Mediterranean monk seal (*Monachus monachus*)

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Marine mammals form ideal repositories for chlorinated hydrocarbons because they are long-lived, having a relatively long exposure time and their lipid depot reserves are very extensive in proportion to their size (GUSKIN, 1982). The fact that they occupy high trophic levels in marine ecosystems results to high chlorinated hydrocarbon concentrations in their flesh and organs (REIJNDERS, 1990).

This study reports on the PCBs, DDTs and HCHs concentrations in several tissues of a mediterranean monk seal, washed out dead at Santorini Island in March 1990. The specimen was an adult male (VI+ years old) having a curvilinear length of 218 cm and a total length of 239 cm (SCHEFFER, 1967). Samples were taken from the muscle, the blubber, the kidney, the liver, the spleen, the heart, the brain and the lung. Each sample was wrapped in aluminum foil and preserved in deep freeze. GC analysis was performed according to SATSMADJIS *et al.*, (1988) on a GC (Varian 3700) equiped with a 63 Ni electron capture detector and a fused silica Megabore column DB-1 30 m long.

Higher PCBs and DDTs values coincided with the blubber (Table 1), observation being in good agreement with the positive relation existing between chlorinated hydrocarbons and lipids in marine organisms (STOUT, 1980). The most contaminated organs were the liver and the spleen. The brain, although having a high amount of lipids, displayed relatively low chlorinated hydrocarbon concentrations. This is mainly attributed to the fact that most of its lipidic compounds are either phospholipids or total cholesterol (KALOGEROPOULOS, pers. com.). Among DDTs, p,p'-DDE exhibited higher values (Fig. 1), due to its higher persistence in relation to the other DDT metabolites (OLSSON 1977).

Table 1. Concentration of PCBs, DDTs, HCHs (ppb on a wet weigt basis) and lipids (%) in various tissues of the mediterranean monk seal collected at Santorini Island in 1990.

	Lipids	PCBs	DDTs	HCHs
Blubber	86.9	15223.3	17163.8	26.7
Muscle	0.7	109.5	174.7	0.9
Kidney	1.5	111.2	166.8	1.0
Liver	2.4	539.9	529.1	1.2
Spleen	2.6	349.5	503.7	1.1
Heart	1.0	47.1	103.7	0.4
Brain	10.8	159.9	160.5	2.2
Lung	0.8	48.0	59.6	0.8

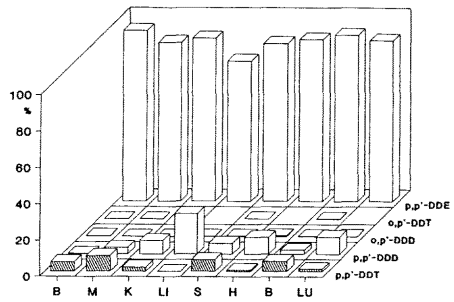

Fig. 1 : Proportion (%) of the DDT metabolites in the various tissues of the mediterranean monk seal. (B=Blubber, M=Muscle, X=Kidney, LI=Liver, S=Spleen, H=Heart, B=Brain, LU=Lung)

Further studies are required in order to collect data on chlorinated hydrocarbon concentrations in mediterranean monk seal, a species endangered with extinction, since these, pollutants affect its ability to resist various diseases and cause failure to reproductive activity (HELLE *et al.*, 1976a & b).

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Contenu en calcium comme indicateur de pollution chez des poissons de Méditerranée

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On sait que les métaux lourds peuvent perturber l'homéostasie calcique chez les mammifères et les poissons. De plus, VIARENGO *et al.* (1988) ont montré que la concentration en calcium total augmentait de manière significative dans la glande digestive de moules exposées aux polluants aussi bien en mer que dans des mésocosmes, contaminés par un mélange de cuivre et d'huile diesel. REGOLI *et al.* (1991) ont observé une augmentation nette de la concentration en calcium total dans la glande digestive et les branchies de moules au cours d'expériences d'accumulation, en conditions contrôlées, de cuivre et de cadmium.

Dans ce travail, nous avons recherché les concentrations en métaux traces (Cd, Cu, Fe, Mn et Zn) et en calcium total dans les branchies de deux poissons : le rouget de vase, *Mullus barbatus*, et le serran, *Serranus cabrilla*. Nous avons choisi d'effectuer ces analyses sur les branchies du fait de l'importance de ces organes (respiration et échanges ioniques); de plus, les branchies sont en contact direct avec le milieu environnant. Les poissons ont été prélevés dans la crique de Cortiou où se déversent, après traitement, les eaux usées provenant de l'émissaire de la ville de Marseille (débit 3 à 4 m³/s). Les prélèvements ont été effectués en mars 1991 à partir du N/O Roselys par chalut, de deux manières: soit parallèlement à la côte (intégrant toute la colonne d'eau entre 80 et 20 m) à 0,4 mille de la côte (TR1) et 0,1 mille de la côte (TR2), soit perpendiculairement à la côte en suivant les isobathes à -30m, -40 m, -50 m, -60 m et -70 m. Les poissons ont été disséqués à bord et les branchies séparées et rincées soigneusement avec une solution de glycine 1 M et TrisHC1 10 mM. Le rinçage des branchies avec cette solution, qui a la même osmolarité que celle de l'eau de mer, permet l'élimination du calcium de l'eau de mer. Les échantillons ont été ensuite lyophilisés et minéralisés par attaque acide. Les analyses de calcium, fer, manganèse et zinc ont été effectuées par spectrophotométrie d'absorption atomique en flamme et celles de cadmium et de cuivre par absorption atomique en four.

Les tableaux 1 et 2 donnent les concentrations en métaux traces et en calcium dans les branchies de *Serranus cabrilla* et de *Mullus barbatus*, respectivement (moyennes des concentrations en métaux de 5 échantillons ± 1 écart-type). Les animaux pris dans la crique de Cortiou sont caractérisés par des concentrations très variables en métaux traces avec des écart-types sur la moyenne parfois supérieurs aux valeurs moyennes. Les concentrations en calcium, en revanche, sont moins variables.

Les branchies de *Serranus cabrilla* (tableau 1) présentent des concentrations moyennes plus fortes en fer, et à un moindre degré en calcium aux stations (TR1 et TR2, prélèvement parallèle à la côte) qu'aux stations qui suivent les isobathes.

Pour les branchies de *Mullus barbatus* (tableau 2), le même phénomène est observé et est significatif. En effet, les concentrations moyennes en calcium, fer et manganèse dans les branchies de ce poisson pêché aux stations TR1 et TR2 sont supérieures (test t significatif à $p<0,01$ pour Ca et Fe et $p<0,05$ pour Mn) à celles trouvées aux autres stations.

Tableau 1: Concentrations en Ca (mg/g), en métaux traces (en µg/g et en ng/g pour Cd) et poids (en g) des branchies de *Serranus cabrilla*.

Station	Poids	Ca	Cd	Cu	Fe	Mn	Zn
- 30 m	.45±.15	65± 8	19± 10	57±94	190± 25	14± 4	101±63
- 40 m	.52±.08	70± 8	57± 49	20±14	161± 41	8± 2	123±59
- 50 m	.55±.07	64± 6	110±172	26±35	144± 14	8± 2	103±59
- 70 m	.57±.21	70± 7	62± 55	22±16	207± 37	8± 2	82±19
TR1	.41±.10	76± 8	63± 46	24±27	246± 87	10± 2	102±24
TR2	.66±.09	73±13	20± 11	12± 6	275±111	10± 5	71± 7

Tableau 2: Concentrations en Ca (mg/g), en métaux traces (en µg/g et en ng/g pour Cd) et poids (en g) des branchies de *Mullus barbatus*.

Station	Poids	Ca	Cd	Cu	Fe	Mn	Zn
- 50 m	.49±.06	37± 2	12± 9	43±18	172± 14	10± 1	94±11
- 60 m	.43±.06	32± 2	106± 22	38±21	207± 29	9± 2	83±15
- 70 m	.39±.09	36± 4	129±148	60±59	195± 31	10± 2	100±26
TR1	.50±.23	55±12	60± 37	38±41	397±174	17± 5	95±17
TR2	.42±.06	51±12	282±272	33± 3	442±176	18±11	96±16

Pour *Serranus cabrilla*, nous comparons ces résultats à ceux obtenus en différents points de Méditerranée Nord-Occidentale (n = 47). Dans ce cas, les branchies ont des concentrations en Ca (76 ± 28 mg/g), Cd, Fe, Mn et Zn qui ne sont pas significativement différentes de celles obtenues à l'émissaire de Cortiou. En revanche, les concentrations en Cu sont beaucoup plus fortes dans les échantillons de Cortiou que dans ceux provenant d'autres points (5,3 ± 2,3 µg Cu/g).

Pour *Mullus barbatus*, la comparaison a pu être faite grâce à des résultats acquis sur des prélèvements (n = 7) effectués en zone côtière près de Banyuls-sur-mer, les concentrations en Ca sont de 43 ± 8 mg/g, en Fe de 295 ± 123 µg/g et en Cu de 3,6 ± 0,7 µg/g. On constate que les concentrations en Ca et en Fe ne sont pas significativement différentes de celles observées aux stations TR1 et TR2. Les concentrations en Cu sont plus faibles que celles trouvées dans tous les cas à Cortiou.

En conclusion, dans la zone de Cortiou on remarque que de nombreux échantillons de *Serranus cabrilla* et de *Mullus barbatus* ont des concentrations élevées en Cu dans leurs branchies, ce qui semblerait indiquer une pollution globale en Cu par rapport à d'autres sites méditerranéens. De plus, on constate dans cette zone une corrélation entre les concentrations en Ca et en Fe dans les branchies de *Mullus barbatus*, (r= 0.716; n= 25). Dans le cas du poisson *Mullus barbatus*, qui vit dans la vase, les concentrations en calcium total des branchies pourraient donc servir d'indicateur précoce de pollution. Par contre, pour *Serranus cabrilla*, aucune corrélation n'a pu être mise en évidence.

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Heavy metal levels in deep sea benthic fauna

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Monitoring studies designated to study the influence of waste disposal operations to the marine environment emphasize the benthic compartment of the ecosystem (sediments and fauna), known to be the ultimate sink of contaminants introduced into it.

Within the framework of monitoring studies conducted in deep sea locations (~ 1,500 m depth) off the Israeli coast, heavy metal contents were determined in sediments and benthic fauna, collected during 1987-1991. The species chosen to serve as indicators were: Crustaceans : *Polycheles typhlops* (n=77), *Acanthephyra eximia* (n=23) and *Aristeus antennatus* (n=23); Fish: *Bathypterois mediterraneus* (n = 8) and *Nezumia sclerorhynchus* (n = 15). The species were chosen based on relative abundance, i.e. presence in almost every haul, and on the representation of different phyla.

Metal concentrations

The concentrations of two non essential metals, mercury and cadmium, and four essential elements : copper, zinc, iron and manganese, were determined in the representative species. Whole specimens were digested with concentrated nitric acid in high pressure decomposition vessels and the metals determined by flame atomic absorption spectroscopy with the exception of mercury, which was determined by cold vapour atomic spectroscopy.

The order of metal concentrations found in the crustaceans was : Fe > Cu > Zn > Mn > Cd > Hg, while in the benthic fish the order was different : Fe > Zn > Mn > Cu > Hg > Cd.

In fish, the level of zinc ranged from 5-12 µg/g wet weight, while copper ranged from 0.5-1.2 µg/g wet weight. In the crustaceans, the level of zinc was similar to that of the benthic fish, while copper concentrations were much higher, ranging between 10 and 130 µg/g wet weight. The differences in copper contents could be attributed to different metabolic processes occurring in crustaceans and fish.

The concentrations of the two non essential metals, mercury and cadmium, found in the crustaceans and benthic fish were much higher than the concentrations found in shallow water species. The crustaceans contained more cadmium than mercury (0.01-2.0 and 0.005-0.3 µg/g wet weight, respectively), while the benthic fish contained mercury ranging from close to the detection limit (0.005 µg/g wet weight) to 1 µg/g wet weight. The high natural concentrations of these two non essential metals in deep sea fauna are not related to the contents of the metals in the sediments (average of 0.01 ppm mercury and 0.12 ppm cadmium; KRESS *et al.*, 1992), and must be a result of the diet and physiological metal regulation of each species. Indeed, it has been found before (FOWLER, 1986) that deep sea pelagic and benthic species in the eastern Mediterranean contain relatively high concentrations of cadmium and mercury.

Manganese concentration in fish ranged between 1-5 µg/g wet weight, while in crustaceans, higher concentrations were observed (1-15 µg/g wet weight). Iron in fish and in the crustaceans *Acanthephyra eximia* and *Aristeus antennatus* ranged between 10-250 µg/g wet weight. The determination of iron concentrations in the crustacean *Polycheles typhlops* posed serious problems. This species is known to live in the sediment, and it was very difficult to eliminate all sediment particles from the animal before analysis, causing a bias in the iron concentration (average iron concentration in the sediments is 6.0%; KRESS *et al.*, 1992).

Size effects

The dependence of metal concentration on size of the animal must be taken into account when establishing baseline levels (RIDOUT *et al.*, 1989). No size effects were detected for all metals in *Polycheles typhlops*. Cd, Fe, Zn and Mn show a log normal distribution with mean concentrations of 0.45, 282,13 and 10 µg/g wet weight, respectively. Copper shows a bimodal frequency distribution with means at 10 and 56 µg/g wet weight (Fig. 1). Hg concentrations were low and close to the detection limit.

In *Acanthephyra eximia*, a marked negative dependence was found between Cd and Zn and weight of the whole animal (r = -0.60 and -0.61, respectively), while no relationship was observed for Hg, Fe, Cu or Mn (Fig. 2). No definite relationship was found between metal concentration and weight for *Aristeus antennatus*. Cu and Zn showed slightly negative dependence on weight. In the benthic fish, a linear relationship exists between Hg and Fe and weight (n=23, r=0.52 and 0.55, respectively). Zn shows a slight negative correlation with weight (n=-0.24), and Cu and Mn concentrations are independent of weight. Cd concentrations were close to the detection limit.

The study of heavy metal concentrations in deep sea fauna, as well as any other constituents, is hindered by sampling time constraints, low abundance of the fauna and the need to analyze a large enough sample in order to filter out the natural variability. The information collected during this study will serve as a baseline for the pristine conditions and will be used for future research on the influence of waste disposal operations in the area.

Acknowledgements

This study was funded by the Israel Electricity Company and Haifa Chemical Industries.

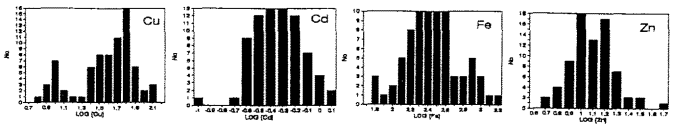

Figure 1: Frequency distribution for the log of observed concentration in Polycheles typhlops

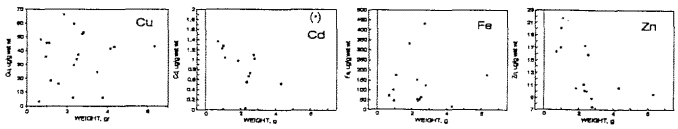

Figure 2: Relations between metal concentration and fresh weight in Acanthephyra eximia

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Atmospheric input of particulate matter to the Eastern Mediterranean

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It is well known that the Eastern Mediterranean Sea is greatly affected by the eolian dusts originated from Sahara desert, and transported to the region by synoptic scale atmospheric features. The magnitude of which is reported by GANOR and MAMANE, 1982 and as an annual flux rate of 50-200 tones per square kilometer. The effect of such inputs is essential in understanding the chemical oceanography of the region. Mediterranean Sea provides an excellent example in providing a study area which is surrounded by industrial, semi industrial and arid countries and by world largest desert belt. The diversity of the catchment areas have further increased the importance of the impact of wind transported materials to the region.

The issue of long term monitoring of the atmospheric fluxes of trace metals to the Eastern Mediterranean Sea has not been well studied and there were no land based stations to cover this aspect. During 1990 a 18 meter high atmospheric collection tower has been constructed at the harbour jetty of the institute (36° 33N, 34°15E) and during 1990 110 samples were collected by using two terylene meshes of 300 m mesh presenting a surface area of 1 m to incoming wind. Since Aug. 1991 Andersen type Hi-Vol samplers and Andersen Wet-Dry deposition sampler utilized to collect atmospheric particulates together with mesh collection technique. During 1990 mesh collection programme dust loadings had reached to a level of 1 g per day. The classification of the dust samples according to Munsell color chart has shown that there exists two main class associated with the dust samples indicating the diversity in catchment areas. The results obtained from the elemental analysis of mesh samples of this study together with some other studies are summarized in Table 1 for comparision.

The elemental analysis of the total atmospheric material collected with Hi-Vol sampler during Aug-Sep 1991 have been completed (35 samples). The average particulate loading durin Aug 1991 was 6.7 $\mu g/m^3$ and for Sep 1991 it was 8.1 $\mu g/m^3$. Results for Pb and Al are plotted on Composite Enrichment Factor (EF) diagrams as explained by SAYDAM, 1981 together with samples collected from other parts of the continent and Western Mediterranean region during EROS-2000 programme Fig.1.

The EF diagram of the Pb has shown that the samples collected will have tendency to fall in a region which indicates a dilution of the European background material by crustal solids. The analysis of the rain samples which are collected by wet-dry deposition sampler has resulted with an average pH of 6.8 and nitrates of 42.5 µM. The preliminary results has shown that these values are in good agreement with the ones obtained at Western Mediterranean EROS 2000 which is classified as Saharan dominated atmospheric materials.

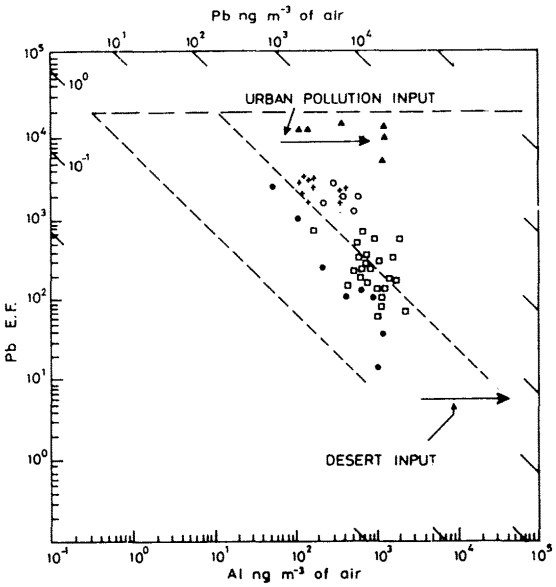

Figure 1. Composite enrichment factor diagram for Pb (after SAYDAM, 1981). Data for the following aerosol samples are plotted : Eastern Mediterranean open-ocean samples (filled circles; data from SAYDAM, 1981); polluted samples from Ghent, Belgium (filled triangles, data from DEMUNYCK *et al.*, 1976 ; U.K. non-urban sites (crosses, data from CAWSE, 1978, 1980) ; "polluted" samples from Cap Ferrat (open circles, data from CHESTER *et al.*, 1989); North Eastern Mediterranean land based station data (open circles, present work).

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Evaluation of some trace metals in sediments from the continental shelf off Egypt

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Sediments are the ultimate sink for contaminants in the marine environment. Evaluation of environment levels in sediments is one approach to assessing environmental impact (SALOMON and FORSTNER, 1984). The pollution problems in the Mediterranean Sea are chiefly due to the discharge of high quantity of untreated water outfall and to virtually total absence of control on toxic components. To determine the extent of pollution in an aquatic system by means of the heavy metal load in sediments, it is of primary importance to establish the natural level of these sediments i.e. the pre civilizational level and then substract it from existing values for metal concentrations in order to derive the total enrichment caused by anthropogenic influences.

The objective of the present study is to determine the levels of some elements (Fe, Mn, Ni, Cu, Zn and Pb) in some scattered samples from the Egyptian continental shelf and to compare them with background levels of normal unpolluted sediments.

This study covers the Mediterranean continental shelf off Egypt between Rosetta (west) and Arish (east).

The studied elements in their total forms were extracted by using hydrofluoric acid in conjunction with nitric and perchloric acids. The present data and the unpolluted reference levels of the studied elements (after TUREKIAN and WEDEPOHL, 1961; Fig 1) were statistically analyzed using correlation analyses between variables, cluster and factor analyses.

The average Fe (6 %) concentration of the present samples corresponds to that given by TUREKIAN and WEDEPOHL, (1961) for the same type of sediments. Unlike Fe the Mn (998.9 ppm) Ni, (89.09 ppm), Cu (44.54 ppm) and Zn (107.9 ppm) average concentrations presently found are lower than their reference levels. The Pb averaging 93.9 ppm slightly exceeded that level reported by TUREKIAN and WEDEPOHL (1961; Fig. 1).

High positive interelemental correlation was observed among the elements (Table 1).

The Fe was very highly positive correlated with Mn, Ni, Cu, Zn and Pb. AUSTRIA and CHORK (1976) showed that Fe may account for more than 50 % of the concentration of Cu, Ni and Zn in sediments. The high positive correlation among the other elements probably reflects their contribution by lithogenic source as previously mentioned by (KRAUSKOPF, 1979).

R-mode factor analysis was used to interpret the interelement associations in the shelf-sediments (Table 2).

Only one factor was produced which appears to be a clay factor. It accounts for 80.5 % (Eigenvalue 4.83) of the total variance and shows a strong association of Fe Mn Cu, Zn and Pb. The mineralogical characteristics of the studied sediments reveal that heavy minerals especially opaques, mainly magnetite and ilimenite are particularly abundant at Rosetta mouth and Cape Burollus. The observed relation in the present study is explained by the sorption or coprecipitation of trace metals with iron oxides in the surficial sediments as previously found by SALOMONS and FORSTNER, 1984.

Table (1): Correlation coefficients matrix.

	Fe	Mn	Ni	Cu	Zn	Pb
Fe	1.00					
Mn	0.82	1.00				
Ni	0.97	0.80	1.00			
Cu	0.71	0.62	0.73	1.00		
Zn	0.90	0.69	0.92	0.60	1.00	
Pb	0.82	0.57	0.85	0.58	0.83	1.00

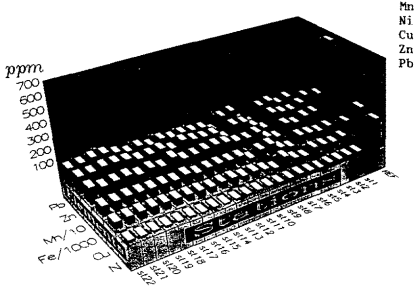

Fig. (1) : Distribution of elements including reference data.

The Q-mode cluster analysis was employed including the reference data. This dendrogram (Fig 2) showed two clusters. The first cluster group includes all samples of the present study. The second cluster group comprised the only reference sample. All samples in the first cluster were combined at short distances showing great similarity (Fig 2). The two clusters showed great dissimilarity as the results were clearly lower for Mn. Ni, Cu and Zn.

Table (2) : Factor Matrix.
Variable Communality Factor : 1

FE	0.95186	Eigenvalue	: 4.83
Mn	0.69691	PCT	: 80.5
Ni	0.96749	C.P.	: 80.5
Cu	0.60411		
Zn	0.85644		
Pb	0.75412		

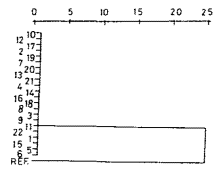

Fig. (2): Cluster Dendrogram

The elements introduced into the study area are either associated with solid material or as elements whose sources are the river runoff or sea water. The main cause that control the elemental composition of the sediments is the relative proportion of the component minerals. The terrigenous deposits are enriched by trace elements generally incorporated in clay minerals.

In general the studied elements are simply referred to as geochemical. No clear evidence has supported the anthropogenic origin of these elements.

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Methodological approach aimed at evaluating the sanitary-environmental risks in a marine area used as a dumping groundof material deriving from lagoon dredging

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This research aims at identifying a series of "guide parameters" to assess the impact produced on the marine ecosystem by the dumping of lagoon muds with a high concentration of nitrogen, phosphorus, mercury and indicators of fecal pollution in an area in front of S. Andrea Island, comprised between Porto Buso and Lignano Sabbiadoro (Northern Adriatic).

The relative proximity of the Lignano tourist resort and the continuous harvesting of edible lamellibranch mollusks from natural colonies advised to extend the investigations in order to quantify any hygienic-sanitary and toxicologic aspects related to dumping operations (1).

In the period between December 1991 and February 1992, about 60,000 c.m. of lagoon muds were dumped in a limited section of an area authorized by the Italian Ministry on Environment.

In September 1991, before these operations began, by using a modified Van Veen grab, a series of samplings were carried out on the sediments of the stretch of the Marano Lagoon that had been subjected to dredging and in the marine area chosen to receive the dredged material, with the aim to characterize the sediments and highlighting any possible differences.

Investigations were confined to the following standard regarded as the most significant: granulometric profile in order to follow sediment redistribution; total nitrogen and total phosphorus with the aim to characterize the risk of a release of "eutrophicating" agents; mercury, to evaluate the risk itself and as a more general indicator of contamination from bio-cumulative stable micropolluting agents; total microbic load to evaluate the general process of microbic contamination; total coliforms to assess the infectivologic risk related to the consumption of edible mollusks and bathing activities.

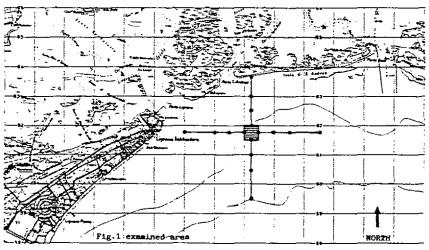
16 sampling sites were identified as indicated in the annexed figure: the first four located along the perimetric sides of the area affected by the dump (400 m wide); the following four about 500m away from the former, arranged along the orthogonal directrices to the sides; another four at another 500 m., and the last ones at 2000 m. from the first group of four.

A second series of samplings was carried out at the end of the dredging operations, in February 1992, evaluating at the same time any release phenomena into the body of water by means of a series of water samplings taken at the surface and at 1 metre from the sea-floor.

The monitoring model used allowed to underline a significant previous contamination of marine sediments with regard to microbiological parameters (sometimes of the same level) and mercury (up to 10 times more abundant than in the lagoon) in addition to underlining the great differences in the grain-size distribution of the marine sediment which, seaward, showed marked analogies with lagoon sediments. It also made possible to clearly identify the various concentrations of total nitrogen in marine sediments, 3 to 5 times lower than lagoon sediments.

The first series of inspections carried out after the dumping operations identified a considerable modification of the sediment only confined to the area affected by dumping, whereas transfer phenomena from sediments to water were not observed.

The fine fraction of lagoon sediments, resuspended by dumping operations and by the action of the waves, appears to be responsible for the transfer of pollutants.



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Pollution of Aegean Sea by petroleum aromatic hydrocarbons

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The increasing use of crude oil as an energy source as well as a petrochemical feed-stock has created an increased world concern regarding the environmental pollution due to petroleum hydrocarbons.

The aromatic hydrocarbons (PAH) are of particular interest because the toxicities of various oils have been associated to their aromatic content. This class of compounds are generally more soluble (1ppb-30ppm) than paraffins, with a low vapour pressure, while a considerable percentage of them, 5-20%, is considered to be carcinogenic.

Conventional Fluorescence Spectroscopy is a useful technique for the analysis of aromatic hydrocarbons due to its greater sensitivity and selectivity for this class of compounds (SAWICKI, 1964). However, the usefulness of this technique is limited by the complex nature of aromatic mixtures in petroleum and the overlapping of fluorescence patterns. LLOYD, 1971 has considerably improved this technique by varying simultanously both $\lambda^{exc.}$ and $\lambda^{em.}$ while keeping a constant wavelength interval $\Delta\lambda$ between them. This technique of synchronous scanning has been proved very successful in multicomponent analysis, as it offers several advantages including narrowing of spectral bands, enhancement in selectivity by spectral simplification and decrease of measurement time.

In addition, the spectra maxima can be related to the number of the fused rings of the PAH. The spectrum of a higher ring number PAH occurs generally at a longer wave-length than a lower ring number compound (Fig. 1).

Therefore, we have applied the above technique for the analysis of surface marine sediments from the Aegean Sea, for the estimation of Pollution levels by petroleum hydro-carbons as well as to obtain a rough of a mlxture of idea of the relative importance of the PAH sources.

Surface sediments were collected during November 1991 and the sampling sites are shown in Figure 2. PAH content was determined fluorimetrically according to the standard methods of IOC (UNESCO, 1984) and the calculated values varied from 0.5 to 1.6 µg/g (in chrysene equivalents).

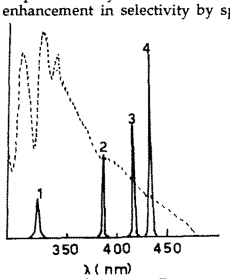

Fig.1 Synchronous fluorescence spectra ($\Delta\lambda$=4) of Kuweit crude oil (--) and a mixture of naphtalene (1), anthracene (2), benzo (a)pyrene (3) and pelylene

The obtained synchronous fluorescence spectra ($\Delta\lambda$=4 nm) implies the presence of naphthalenes (300-340 nm), aromatic compounds with three to four fused rings (340-400 nm) and highly condensed aromatics (400-500 nm) in considerably higher amounts. However such a wide range of aromatic compounds but with much more less amounts of multiringed aromatic compounds is typical of petroleums composition (Fig. 1). The predominance of aromatic hydrocarbons containing five and more rings indicates that these compounds are coming primarily from atmospheric dustfall and in most cases they have pyrogenic origin (products of incomplete combustion of fossil fuels) .

Fig.2. Sampling sites and values of PAHs in sediments of Aegean sea (µg/g in chrysene equivalents)

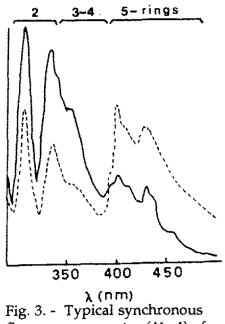

Fig. 3. - Typical synchronous fluorescence spectra ($\Delta\lambda$=4) of PAHs extract in hexane from Saronikos gulf (-) and from Aegean sea (- -) sediments.

Moreover, it is interesting to note the very intense large doublet centered at about 440nm, in all examined samples, which is indicative of the presence of perylene, a biogenic compound formed in marine sediments by reduction of land-derived nonhydrocarbon compounds, such as hydroquinones.

Finally, the spectra of sediments from Aegean Sea are compared to the corresponding typical synchronous spectrum obtained from sediments of Saronikos Gulf (Fig. 3). Saronikos is a semi-closed gulf of Greece which receives a great amount of sewage from the urban activity as well as from the industries located at the northern part of the gulf. This comparison clearly shows the higher content of two, three and four ring compounds (300-400 nm) in the case of Saronikos gulf, indicative of the petroleum origin of PAHs.

In conclusion, the results obtained in this study show that in the Aegean sea the contribution of PAHs of pyrolytic and eventually biogenic origin is the most important.

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Processus de décontamination de l'eau interstitielle par les métaux-traces pendant une expérience *in situ*

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La plupart des études environnementales ont comme objet l'impact de la pollution sur le milieu marin. Dans le cas de la recherche actuelle était étudié un processus inverse : celui de la décontamination des sédiments superficiels.

Des sédiments provenant d'un site pollué (station 1) ont été transplantés dans un site considéré comme "non pollué" (station 2) ayant les mêmes caractéristiques, à l'exception des sources de pollution (Fig. 1).

On a surveillé l'évolution des teneurs de Cd, Pb et Cu dans l'eau interstitielle pendant cette *in situ* expérience en vue d'étudier la possibilité et le degré de contamination après leur transplantation.

Méthodologie

L'eau interstitielle a été obtenue par centrifugation des sédiments. L'analyse des métaux traces a été réalisée par D.P.A.S.V. (Differential Pulse Anodic Stripping Voltammetry), après filtration et U.V. irradiation des filtrées. Tout le processus était effectué sous hotte à flux laminaire, (pression positive, classe 100), dans un laboratoire spécial, à "poussière limitée", (MART L., 1982).

Résultats-Discussion

Au début de l' expérience les sédiments provenant du site "pollué" présentaient des concentrations plus élevées (en moyenne 107.2 ng/l Cd, 1107.45 ng/l Pb et 1177.10 ng/l Cu) que celles au site de transplantation, ("non pollué"), (en moyenne 8.40 ng/l Cd, 201.63 ng/l Pb et 466.40 ng/l Cu), (Fig.2, 3, 4). Les valeurs élevées des sédiments du site pollué sont attribuées à l'existence des conditions réductantes du milieu pendant l'été; ce qui provoque la formation des complexes polysulfurés stables - Surtout pour le Cd et le Cu, (BOULEQUE, 1981).

Dix-neuf mois après la transplantation les sédiments "pollués" ont présenté une diminution des concentrations des métaux-traces importante. Cette baisse s'élevait au 90.95% du Cd, 73.63% du Pb et 70.74% du Cu de leur valeur initiale, (Fig. 2, 3, 4).

Il est remarquable de noter que les niveaux des concentrations ont présenté des variations au long de l'expérience, attribuées probablement à l'équilibre dynamique entre l'eau interstitielle et la phase solide, (CATSIKI V.A.).

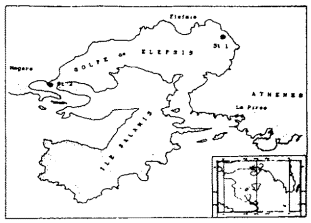

Figure 1: Station 1: site des sediments pollués; Station 2: site de transplantation).

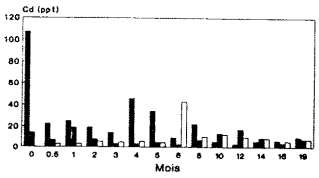

Figure 2: Evolution des taux de Cd dans l'eau interstitielle

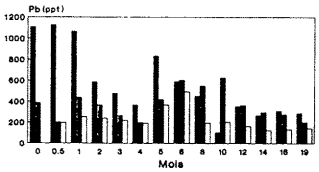

Figure 3: Evolution des taux de Pb dans l'eau interstitielle

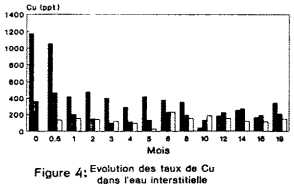

Figure 4: Evolution des taux de Cu dans l'eau interstitielle

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Nutrient investigation in the Saronikos Gulf, Aegean Sea, (1987-1990)

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The seasonal variation of the distribution of the nutrient salts phosphates, silicates, ammonia, nitrites and nitrates as well as of the dissolved oxygen from the standard depths was examined in 14 stations in the Saronikos Gulf, (Fig. 1), during the years 1987-1990.

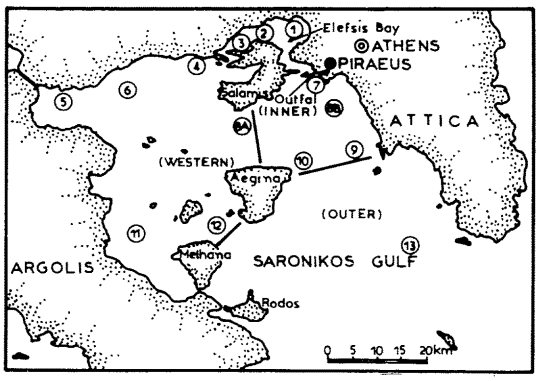

Fig. 1: Oceanographic subregions of the Saronikos Gulf.

The analysis of nutrients was done using a Technicon Autoanalyser according HAGER *et al.*, (1968).

In order to investigate whether the determined values of nutrients were statistically different concerning their geographical, seasonal and annual distribution, the results were treated using the two-way analysis of variance and the Tukey test (TUKEY, 1953). The statistical analysis revealed significant differences among the five subareas of the Saronikos Gulf. Elefsis Bay characterised by a strong eutrophication, presented the highest values of nutrients especially for phosphates (0.08-1.56μg-at P/l) (Fig. 2) as well as for silicates (1.97-9.77 μg-at Si/l) and nitrogen (0.15-3.89 μg-at N/l), while the outer Gulf presented the characteristics of the Aegean Sea with lower nutrient concentrations (0.04-0.22 μg-at P/l and 0.20-1.54 μg-at N/l).

A significant enrichment of nutrients was found in the outlet of the sewage outfall (0.07-1.97 μg-at P/l and 0.59-2.91 μg-at N/l).

A relative accumulation of nutrients, mainly nitrates, was found in the bottom layer of the Western Gulf which, due to its depth and the slow water exchange, acts as a nutrient trap (FRILIGOS, 1983).

As far as the annual distribution of nutrients is concerned a tendency of decrease was found from 1987 to 1989. This was valid mainly for total nitrogen, but not statistically significant (Fig. 3).

The seasonal variations presented significant differences for nitrites and nitrates (Fig. 4). Two maxima were found in March and December, while the lowest values were observed during summer. Ammonia reached its lowest value in June.

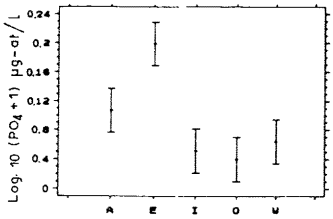

Fig. 2 : Statistical analysis of PO_4 data.

Finally the concentrations of phosphates and silicates presented an irregular seasonal pattern, with no significant statistical differences.

It has to be noted that the differences between dissolved oxygen levels in summer and winter, mainly in Elefsis Bay, were found statistically significant, whereas significant difference was not found between the five subareas. Moreover Elefsis Bay presented the lower values of D.O. (0.00-5.76 ml/l), while the outer Gulf presented the highest (4.75-5.81 ml/l).

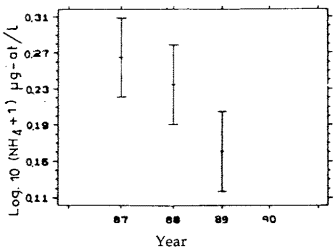

Fig. 3: Statistical analysis of NH_4 data.

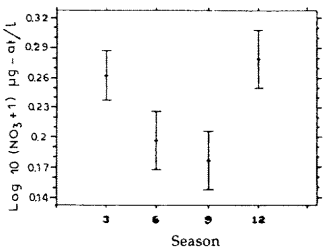

Fig. 4: Statistical analysis of NO_3 data.

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Accumulation of PCBs and induction of Cytochrome P-450 and mixed function oxygenase activity in juvenile sea bass *(Dicentrarchus labrax)*

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The early developing stages of marine fish are known to be more susceptible to environmental stress and pollution than mature animals; however, few data are available on the biochemical response to toxic and genotoxic chemical contaminants (1).

In this paper, we report the first results of laboratory experiments in wich specimens of *Dicentrarchus labrax,* a widely distributed fish in the Mediterranean Sea, were exposed to relatively low concentrations of PCBs in water.

About 50 juvenile sea bass, one month old and about 1 gram weight, were kept in 80 dm3 tanks in areated sea water. After seven days of acclimation, a solution of Aroclor 1254 (10 mg/cm3 ethanol) was added to give a PCB concentration of 1 µg/dm^3 (tank A) and 10 µg/dm^3 (tank B). Daily, about 5 g of fish feed were added to each tank; then half the water was renewed and a proportional solution of Aroclor 1254 added. Specimens of juvenile sea bass, in which tail was not developed probably due to irradiation during the first embrional stages, were also exposed to 10 µg/dm^3 PCB in water (tank B). Control tanks, without PCBs, were kept for the entire experimental period.

At 0, 7, 15 and 30 days of exposure, six fish from each tank were sacrificed and divided in two pools : the first one was used for PCB determination, while the second fraction was homogenised and analysed for Cytochrome P-450 content (2) and for BPH (3) and NAD (P) H reductases (4) activity in microsomal pellets. Protein concentration was measured by the method of LOWRY *et al.*, (5). The PCBs in water and fish were determined by ECD gas chromatography according to FOSSATO (6).

The results are reported in Tables I and II.

Table I

Dicentrarchus labrax; juvenile fish without tail treated with PCB Aroclor 1254; C= control, B= 10 µg/dm^3. Data, referred to wet weight, are expressed as follows : Time = days; Protein = mg pr/g; PCBs = µg/g; P-450 = nm protein/mg; BPH = fluor unit protein/mg min.; NAD (P) H ferricyanide and Cytochrome c reductase = nm reducted/mg protein min.; n. d. = not detected.

Time	Tank	Protein	PCBs	P-450	BPH	NADHferr	NADHcitC	NADPHcitC
O	C	3.47	0.02	0.111	6.79	1202	1.15	7.16
O	B	4.34	0.02	0.063	3.89	825	n.d.	7.44
7	C	3.44	0.03	0.028	3.07	1098	n.d.	n.d.
7	B	1.99	3.17	0.052	n.d.	1392	57.12	4.00
15	C	3.47	0.09	0.064	0.03	1078	n.d.	n.d.
15	B	2.62	3.69	0.143	3.53	1096	n.d.	n.d.
30	C	2.94	0.11	0.028	n.d.	866	n.d.	n.d.
30	B	2.01	12.45	0.056	7.34	1486	n.d.	n.d.

Table II

Dicentrarchus labrax; juvenile fish with tail treated with PCB Aroclor 1254; C = control, A = 1 µg/dm^3 , B = 10 µg/dm^3. Data, referred to wet weight, are expressed as follows : Time = days; Protein= mg pr/g; PCBs= µg/g; P-450= nm protein/mg; BPH = fluor. unit protein/mg min.; NAD (P) H ferricyanide and Cytochrome c reductase = nm reducted/mg protein min.; n. d. = not detected.

Time	Tank	Protein	PCBs	P-450	BPH	NADHferr	NADHcitc	NADPHcitc
O	C	1.41	0.02	0.053	n.d.	1155	n.d.	4.66
O	A	1.28	0.02	0.084	n.d.	1055	n.d.	9.09
O	B	2.75	0.02	0.084	1.99	941	n.d.	n.d.
7	C	1.09	0.03	0.080	3.86	1263	7.66	n.d.
7	A	1.59	0.33	0.088	n.d.	1574	n.d.	3.66
7	B	1.37	2.45	0.087	2.86	1049	n.d.	n.d.
15	C	1.62	0.08	0.118	4.60	1389	n.d.	n.d.
15	A	1.97	0.46	0.082	10.20	1541	n.d.	7.00
15	B	1.64	5.29	0.209	14.26	1687	2.10	10.11
30	C	1.07	0.13	0.035	n.d.	768	10.87	8.35
30	A	1.80	1.01	0.030	2.39	1333	n.d.	7.65
30	B	0.82	10.22	0.050	5.74	1151	12.56	16.53

The PCB content showed an increase with time in both treatments, reaching the highest values in animals from tank B. After 30 days of exposure to a nominal concentration of 10 µg/dm^3., the bioconcentration factor, on a wet weight basis, varies between 1,000 and 1,200, indicating an active bioaccumulation.

The pattern of enzymatic parameters is more complex and erratic. Cytochrome P-450 showed a clear increase over the control in treatment B after two weeks of exposure, but it decreased to the end of the experiment.

NADH ferricyanide reductase activity presented a slight increase in both experiments, the difference between treated fish and control becoming evident at 30 days.

NAD (P) H Cytochrome c reductases and BPH activity showed no clear responses, the values often being near the detection levels.

These preliminar results indicate an active bioaccumulation of PCBs by juvenile sea bass and give evidence of contaminant induced damage at the biochemical level for tissue PCB content of about 10 µg/g wet weight.

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Detergents in Alexandria Western Harbour

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The western harbour of Alexandria is the main trade harbour of Egypt . It receives about 6 x 10 million cubic meteres daily of untreated industrial, agricultural and domestic effluents. The harbour basin is considerably contaminated by various organic and inorganic pollutants. It covers an area of about 31 km^2, comprises shallow inner and outer basins and has an average depth of 7m .

The aim of this work is to elucidate the pollution level with detergents in the very important Egyptian harbour and their relations with the hydrographical parameters such as salinity and nutrients.

Material and Methods

Water samples were collected monthly during the year 1989 from surface, 5m depth and near the bottom at eight localities representing the different regions of the harbour (Fig.1), using a plastic Ruttner sampler. Anionic surfactants were determined according to the Methylene method (APHA),1980) .

Results and Discussion

The anionic surfactants showed pronounced temporarly variations, mostly coincided with the rate of allochthonous effluents discharge into the harbour. Low values were recorded during autumn months, moderate concentrations were detected in winter and spring while the highest contents were in August (Fig. 2). COSVIC *et al.*, (1979) observed high seasonal increase of detergents during phytoplankton blooms, what is in a good agreement with the present finding. One of the consequences is that the amount of detergents is concentrated mostly in the surface water layer, sometimes doubled the bottom value.

With regard to spatial variations, relative high amounts of detergents, up to 1.21 mg/1 were estimated in the inner harbour in the vicinity of the sewers. The sheltered area in the outer harbour, st. 5, comprised the maximum value of 1.47 mg/1, these two high values were measured in the surface samples of August. At the Coal-Quay ; st. 7, the water column, on the other hand, exhibited the lowest amounts of detergents during most of the year where the values reached sometimes (<0.10 mg/1).

Based on regression analysis, a significant inverse correlation coefficient between detergents with salinity (r = -0.505, p <0.001) and a positive coefficient with silicate (r = 0.452, p< 0.001) were calculated whose indicate the allochthonous origin of detergents in the harbour (sewage). This suggestion is much confirmed from the significant positive correlations between the detergents contents and each of ammonia (r = 0.250, p<0.001) and oxidizable organic matter (r = 0.191, p < 0.001).

Statistic correlations were also calculated between detergents and different forms of phosphorus (total dissolved ; TDP, dissolved inorganic ; DIP, dissolved organic ; DOP, particulate ; PP and total phosphorus ; TP are summarized as follows :

TDP > DIP > DOP > PP > TP
r = 0.403 0.311 0.252 0.156 0.058 (p < 0.001)

These coefficients explain the relation between the concentration of methylene blue active substances in the harbour and phosphorus content particularly its dissolved forms.

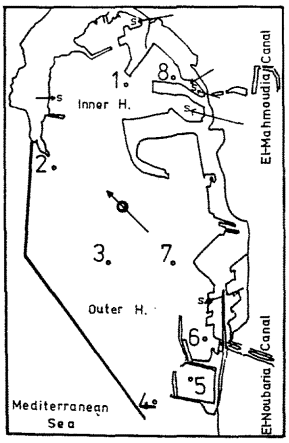

Fig. 1. Alexandria western Harbour ; Sampling Locations & Sewers (s)

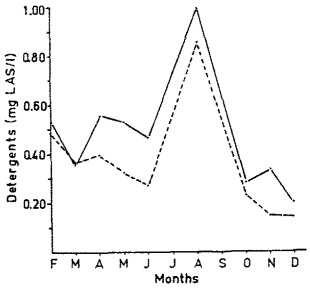

Fig. 2 Monthly averages of detergents in surface . —— . and bottom waters .------. during the year 1989.

Compared with the mean value of anionic surfactants in El-Agami area (a reference unpolluted open water, ABOUL-KASSIM, 1990) the western harbour exhibits average being 16 folds. According to the finding of MAHMOUD and BELTAGY, 1988, in lake Borollos the present average is nearly doubled or closely similar to that obtained in abu-Qir Bay (SAID *et. al.*, 1991).

On the basis of the frequency distribution of anionic surfactants content, most of the samples (> 60%) exhibited 0.25 - 0.50 mg/1. The values > 1.00 mg/1 did not exceed 5% of the samples. This indicates that the western harbour is still far from strong pollution with anionic detergents what is in agreement with the finding of ABOUL-KASSIM, 1990 in Alexandria coastal waters .

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Changes in sediment toxicity to sea urchin sperm as a function of sample processing. I. Toxicity of solid phase vs. water extracts

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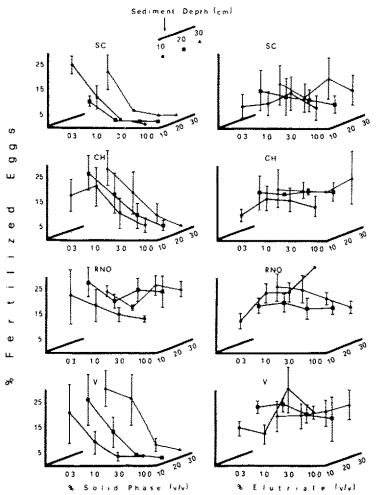
In a previous study of water and sediment toxicity on sea urchin embryos and sperm (PAGANO *et al.*, 1992), we have observed that water samples from polluted water bodies displayed only minor toxicity, whereas sediment samples from a number of river, estuary and coastal sites exerted toxic outcomes to fertilization and early development with clear-cut results, consistent with the pollution status of the samples. Thus, it may be suggested that testing sediment toxicity may provide comprehensive information on the environmental health status of a water body, also in relation with the difficulties of obtaining reliable data on the toxicity of the water column. In this study, we have tested sediment toxicity from some selected sites of a brackish water body located in Southern France (Etang de Berre). The study has been conducted by utilising sea urchin sperm and embryo bioassays on *Paracentrotus lividus* (PAGANO *et al.*, 1986).

The question is raised whether the best conditions for a realistic bioassay should be obtained in the presence of whole, untreated sediment (including solid phase), or by testing water extracts ("elutriate") from sediment samples. Another relevant question in sediment toxicity testing relates to which depths in a sediment core may provide the most realistic information on sediment toxicity. Thus an appropriate sampling procedure should be standardised concerning the most suitable depth(s) of sediment core.

We conducted two series of experiments testing the spermiotoxic action of sediment samples collected from four sites at the Etang de Berre, labeled SC, CH, RNO and V. Each sample was divided into three subsamples corresponding to the depths of 0-10cm, 10-20cm and 20-30cm from surface, which were processed separately. An aliquot from each subsample was then suspended (10%) in seawater, stirred and maintained overnight at + 4°C; the water extract (elutriate) was obtained by centrifugation (350xg, 10min). Solid phase sediment aliquots were maintained in the same conditions as those designed to obtain elutriate (except for centrifugation). Both solid phase suspensions and elutriate were tested in v/v dilutions ranging from 0.3% to 10%. Sea urchin (*P. lividus*) sperm suspensions (1% dry sperm) were added gently to filtered seawater containing solid phase sediment (without resuspending the pellet) or elutriate; after a 15-min exposure, sperm was used to inseminate untreated egg suspensions (1:100 sperm:eggs; approx. 100eggs/ml); thereafter, zygotes were washed by decantation with control seawater. Changes in fertilising capacity were determined by reading fertilization rate (FR = % fertilised eggs) in live embryos starting from early cleavage. In a series of experiments on developmental toxicity, *P. lividus* zygotes (10min after fertilization) were exposed to sediment or elutriate throughout embryogenesis up to the larval stage of pluteus. Developmental defects were scored according to PAGANO *et al.* (1986) both in the cultures exposed during development and in the offspring of pretreated sperm.

As shown in Fig. 1, solid phase sediment from three sites (SC, CH and V) showed dramatic spermiotoxicity, with a drop in fertilization rate (FR) to zero between 1% and 3%; on the other hand, sediment from the site RNO only showed minor effects. Elutriate samples invariably showed a lesser spermiotoxicity than solid phase, without any dose-response trend and, at sites RNO and V, a slight increase in FR was observed. As observed in Fig. 1 and confirmed in a subsequent series of experiments, a clear-cut depth effect was observed at site SC and, to a lesser extent, CH, in that the 10-cm sample showed the least spermiotoxicity as compared to 20-cm and 30-cm samples; no such effect could be detected at site V, where spermiotoxicity appeared to be evenly distributed across the three depth segments. Again, RNO site only showed minor spermiotoxicity, if any, at all depths considered. The offspring quality of sediment-pretreated sperm (either solid phase or elutriate) in no case appeared to be affected. The exposure of embryos throughout development failed to provide any evidence of an embryotoxic/teratogenic action at 1% sediment (solid phase only).

These results confirm the suitability of solid phase in sediment toxicity testing. Moreover, our present data suggest that water extraction of sediment samples may result in non-realistic observations or false negatives.



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Changes in sediment toxicity to sea urchin sperm as a function of sample processing. II. Effects of sample storage temperatures

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When testing sediment toxicity, some problems may arise from the facts that: a) immediate; testing may not always be feasible, and b) in many cases a delayed replicate of test(s) may be needed. On the other hand, storing sediment samples for later bioassays meets the difficulties related to the alteratic induced by sediment-associated microorganisms that can affect sample toxicity by a number mechanisms. Thus the question is raised about the most suitable storage conditions for sediment samp in toxicity testing. If a chemical preservation technique is excluded *a priori*, then a basic choice may confined to either storing sediment samples at +4°C or at -20°C. In both cases some inconveniences in occur, since refrigeration does not prevent microbial activity, whilst freezing-and-thawing may result undesired artifacts in the structure and/or composition of sediment samples, turning into changes of th toxicity.

Seeking an at least partial answer to the above questions, we tested sediment toxicity samples from four freshwater sites in Campania, Italy. The sites were labeled S.1 (Solofrana Stream), (Sarno River), and V.6 (mouth of Regi Lagni drainage system), all being affected by a number of pollution sources, and V.3, a reference site in the Volturno River. All sites were characterised both for a series inorganic and organic pollutants, and for granulometry (MELLUSO *et al.*, 1991; PAGANO *et al.*, 1992). Each sediment sample was carried refrigerated to the laboratory, and thereupon divided into three subsamples, each stored overnight as follows: a) at -20°C; b) at +4°C, and c) dessiccated at +60°C (for dry weight determination). Thereafter, the samples (a) and (b) were suspended at the concentration of 1 (dry weight equivalent) in seawater and allowed to settle in containers. Bioassays were carried out on c urchin sperm and embryos (*Paracentrotus lividus* and *Sphaerechmus granularis*), processed according PAGANO *et al.* (1986), and applying the same schedules described in the first section of this paper.

Following a 15-min sperm pretreatment (*P. lividus*) in sediment-containing seawater spermiotoxicity was affected according to sample storing conditions, in two out of four sampling sites shown in Table 1, samples from sites S.3 and V.6 displayed a dramatic shift in their spermiotoxicity, in that refrigerated samples were significantly more spermiotoxic than freeze-thawed samples. *Vice versa*, sample was spermiotoxic, and V.3 was non-spermiotoxic, both following refrigeration and freeze-thawing of samples. These effects were consistently observed in a subsequent series of sediment sampling a experiments on *P. lividus* (totalling 10 sperm lots from 45 males). A triplicate experiment on *S. granula* sperm, limited to three sites, partially confirmed the above data (in two out three sites).

When developing embryos were reared in sediment samples stored at +4°C or -20° embryogenesis was affected by each sample independently of sediment storage temperature; this held true both for the kind of effect and for the frequencies of abnormalities. Namely, S.1 sample caused an early embryonic mortality (arrest at zygote), S.3 and V.6 samples induced developmental abnormalities, and failed to affect development, as observed previously (PAGANO *et al.*, 1992). In each case, these effects was observed independently of whether sediment samples had been stored at +4°C or -20°C.

Regarding spermiotoxicity experiments, one may speculate about the apparently contrastion behaviour of site S.1 (thawing insensitive, mainly affected by industrial, inorganic pollutants) vs. sites and V.6 (thawing sensitive, characterised by agricultural and domestic pollution). Among possible interpretations, it might be suggested that spermiotoxic agents being present at sites S.3 and V.6 might biopolymers or other organic contaminants, whose toxicity could be affected by thawing-associated changes.

The lack of any differences in sediment embryotoxicity according to storage temperature may be partly related to the different exposure of embryos, as compared to sperm; unlike sperm, only being exposed in suspension for 15min, the embryos had a longer (72hrs) and partly direct contact with sediment (approx. 10hrs up to hatching); moreover, the toxicants and/or the mechanisms involved in spermio-embryotoxicity are expected to be different, thus accounting for the observed outcomes.

Independently of the possibility to observe or not an effect of storage temperatures sediment toxicity, it should be stressed, however, that freeze-thawing procedures should be avoided was storing sediment samples, in order to prevent artifacts in toxicity endpoints. Moreover, since microbial activity may as well affect any toxic outcomes in refrigerated sediment samples, these should be tested toxicity as shortly as possible after their collection.

Table 1. Fertilisation Rate (% fertilised eggs) in *P. lividus* embryos following a 15-min sperm exposure to seawater containing 1% (dry wt. equivalent) sediment stored at + 4°C or -20°C. Quintuplicate experiment on a total of 25 males.

Site	Fertilisation Rate +4°C	Fertilisation Rate -20°C
Control	88.7 + 3.5	
S.1	47.6 ± 11.7	45.4 ± 8.5
S.3	9.4 ± 3.3	88.2 ± 3.2
V.3	89.4 ± 1.8	72.2 ± 9.9
V.6	6.0 ± 1.5	77.4 ± 6.1

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Metal pollution in the Heli Bay, Greece

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Heli Bay is a semi-enclosed Bay, situated at the southern coast of Argolis Peninsula, Greece. The water depths in this area vary between a few and 15 meters. The town of Portoheli, at the northwestern coast, and the surrounding beaches are considered as major and of high standard resort places in Peloponnese.

In order to investigate the environmental conditions in the Heli Bay, dissolved oxygen and pH measurements were carried out. In addition, seafloor sediments collected with a Van-Veen grab were analysed for major and trace elements, including toxic metals. The chemical analyses were carried out using Inductively Coupled Plasma(I.C.P.) after an HF-HNO_3-$HClO_4$ diggestion.

The dissolved oxygen and pH values were found to be within the range of normal coastal seawater. pH varried between 8.1 and 8.6, while dissolved oxygen between 7.5 and 8.4 mg/l.

The geochemical data showed significant enrichments in Cd, Hg, Sb, Ag, Pb, Mo and Cr relative to near-shore normal sediments (GRIMANIS *et al.*, 1977; SCOULOS and DASENAKIS, 1982; VOUTSINOU-TALIADOURI, 1984; VARNAVAS *et al.*, 1987, 1988; PANAGOS *et al.*, 1988; VARNAVAS and CRONAN, 1988). The highest concentrations of Cd and Sb were found at the north western coast, while the maximum Cr value at the northeastern coast of the Bay. The sediments of the central part of the Bay are characterised by anomalously high concentrations of Sb,Pb,Mo and Hg.

The application of factor analysis on the geochemical data showed that factor 1 accounts for 51,3% of the data variance and shows strong loadings on A1,Fe,Zn,V,Cu and Co.This factor represents the clay-fraction of the sediments and demonstrates its strong contribution in the incorporation of trace elements to the sediments. Factor 2 accounts for 15.8% of the data variance and shows strong loadings on Mo, Hg and Pb. Since Mo is an indicative element of reducing conditions it is implied that this factor represents the organic fraction of the sediments. It demonstrates the strong contribution of organic carbon in the incorporation of toxic metals to the sediments. Factor 3 accounts for 11.8% of the data variance and shows strong loading on Si, Cr and P, representing the weathering products of magmatic rocks. Factor 4 accounts for 7.6% on the data variance. It shows loading on Mn, representing the manganese oxides. Factor 5 accounts for 4.3 % and factor 6 for 3.5% of the data variance and they show loadings on Ag and Ca respectively. Factor 5 demonstrates the different origin and behaviour of Ag while factor 6 the low contribution of carbonates to the sediments. (Table 1).

Table 1 : Varimax rotated factor matrix

Factor	1	2	3	4	5	6
SiO_2	-0.18209	-0.10138	0.74966	-0.52093	-0.18583	-0.14658
Al_2O_3	0.80847	0.45804	-0.18220	0.19541	0.20781	0.06873
Fe_2O_3	0.81910	0.48488	-0.17791	0.17055	0.12855	-0.00273
TiO_2	0.66280	0.53362	0.40167	0.08724	0.14964	-0.02154
MnO	0.65527	0.34413	0.27259	0.44890	0.13303	0.05148
CaO	0.12488	0.05713	0.10000	-0.02155	0.18837	0.96101
P_2O_3	-0.03021	-0.19423	0.94768	0.18880	0.02653	-0.08858
Zn	0.90308	0.22327	-0.19418	-0.02282	0.07695	0.13058
V	0.80955	0.42207	-0.19813	0.27309	0.17127	0.01981
Cr	-0.24074	-0.23372	0.93793	0.03815	-0.05317	-0.06052
Cu	0.77090	-0.18720	-0.16315	0.03790	-0.32542	0.25885
Co	0.82341	0.38997	-0.12983	0.28411	0.19142	-0.12117
Pb	0.24829	0.90765	-0.23973	-0.13105	0.07650	-0.01864
Cd	-0.25544	0.14115	-0.02034	-0.90328	0.08923	0.06599
Mg	0.27179	0.89501	-0.18324	-0.03331	0.15076	0.04885
Mo	0.50784	0.79112	-0.23989	0.04528	0.18735	0.09364
Ag	0.17406	0.20181	-0.06693	-0.04503	0.92786	-0.14881

It is concluded that in the Heli Bay significant amounts of toxic metals accumulate on the seafloor. Their association with non-detrital minerals suggests that under certain physicochemical conditions may be released in the seawater from which they can get into the food-chain.

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Des données préliminaires sur la dynamique du Mercure (Hg) dans la musculature de trois espèces de poisson marin, sur la Côte Albanaise

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Le but de ce travail était de suivre la concentration de mercure (Hg) dans la musculature de trois espèces de poisson marin, également de voir s'il existe une interdépendance entre la concentration de mercure et l'espèce de poisson, la station où sont pris les échantillons, ainsi que l'âge relatif du poisson.

Les échantillons de cette étude sont récoltés en janvier 1992, dans les trois zones de la Côte Albanaise : celle de Saranda, de Vlora et de Durrës (Carte 1). Dans le Golfe de Vlora, une usine de P.V.C. rejete ses déchets qui contiennent du mercure (Hg).

Les espèces de poisson qui ont été analysées sont : *Sardina pilchardus, Mullus babatus et Trachurus trachurus*. La concentration moyenne de mercure, dans la musculature des trois espèces est de:

- *S. pilchardus*, Saranda 140, 25±3,31 ng/gr p.fr; Vlora 137,67±3,23 ng/gr p.fr.; Durrës 78,76± 2,28 ng/gr p.fr.
- *Trachurus trachurus*, Saranda 54,71±1,11 ng/gr p.fr.,; Durrës, 74,35±2,71 ng/gr p.fr.
- *Mullus barbatus*, Saranda 50,48±2,71 ng/gr p.fr.; Vlora, 139,75±4,03 ng/gr p.fr.; Durrës 88,8±2,43 ng/gr p.fr.

La concentration moyenne de mercure dans la musculature des trois espèces, pour la côte Albanaise, de Saranda à Durrës, est de :

- *S. pilchardus*, 119,06±1,95 ng/gr p.fr.
- *T. trachurus*, 61,85±1,35 ng/gr p.fr.
- *M. barbatus*, 86,79±2,02 ng/gr p. fr.

La comparaison de nos résultats avec ceux des autres pays (ci-dessous), met en évidence que la concentration de mercure (Hg) chez les deux espèces de poisson de notre côte, est le plus bas.

- *S. pilchardus* du Golfe d'Izmir (Turquie) contient 180 ng/gr p. fr. (Hg); du Golfe Abu Qir (Egypte) 230-245 ng/gr p. fr. (Hg); de la zone de Castellon (Espagne) 21-330 ng/gr p. fr. (Hg).
- *M. barbatus*, du Golfe de Trieste (Italie) 40-220 ng/gr p. fr.; du Golfe d'Izmir (Turquie) 410 ng/gr p. fr.; de la mer Egée (Grèce) 150-320 ng/gr p. fr.

L'effet des facteurs "espèce de poisson" et "station" sur la concentration de mercure (Hg) est mis en évidence par l'analyse de la variance selon le modèle linéaire avec des facteurs fixes.

$$Y_{ijk} = \mu + a_i + b_j + e_{ijk} \quad (1) \text{ où:}$$

Y_{ijk} = la valeur de la concentration de Hg dans l'espèce "i" qui se trouve dans la station "j".
μ = moyenne.
a_i = effet de l'espèce de poisson (i = 1,3).
b_j = effet de la station (j = 1,3).
e_{ijk} = effet aléatoire résiduaire.

L'analyse de la variance montre que les deux facteurs étudiés présentent les effets significatifs (P<0, 01) sur la variation d la concentration de Hg.

Pour étudier l'action réciproque "espèce de poisson" et "station" on a réalisé l'analyse de la variance selon le modèle linéaire, y compris aussi les facteurs "âge" et "poids" du poisson.

$$Y_{ijkln} = \mu + a_i + b_j + s_{kl} + e_{ijkln} \quad (2)$$

Y_{ijkln} = la valeur de la concentration de Hg.
μ = la moyenne.
a_i = effet de l'âge du poisson (i = 1,5).
b_j = effet du poids du poisson (j = 1,4).
s_{kl} = effet de l'action réciproque "espèce x station".
e_{ijkln} = effet aléatoire résiduaire.

L'analyse de la variance montre que les facteurs "âge" et "poids" ne sont pas significatifs dans la variations de la concentration de Hg. On pense qu'un telle situation peut être le résultat du nombre assez faible d'échantillons étudiés.

L'effet de l'action réciproque "espèce x station est significatif (P<0, 05), donc la concentration de Hg dépend de l'espèce de poisson et des caractéristiques du milieu de vie.

Même si les données sont préliminaires, on peut tirer certaines conclusions:

- la concentration de Hg, dans la musculature du poisson dépend de l'espèce. Parmi les espèces étudiées, *S. pilchardus* présente la concentration la plus élevée.
- la concentration de Hg pour les trois espèces étudiées est plus forte dans la zone de Vlora. Celà est liée à la présence de l'usine de P.V.C. dans le Golfe de Vlora.
- la comparaison de nos résultats avec ceux de certains pays montre que la concentration de Hg, dans la musculature de *S. pilchardus* et *M. barbatus* de notre côte est plus bas. Celà pourrait être dû au fait que l'usine est assez récente et que donc les déchets ne sont pas rejetés directement dans l'eau de mer; le Golfe de Vlora est très fermé.

Organochlorine residue content in Red Mullet (*Mullus barbatus*) from the Greek Seas

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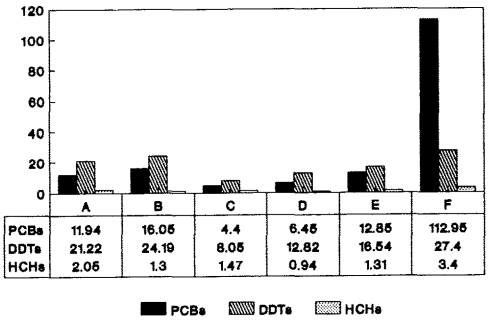
Organochlorine compounds, such as PCBs, DDTs, HCHs, along with technical impurities and metabolites belong to the most persistent and toxic pollutants in the environment, and accumulate in adipose tissues of marine organisms. In order to study the extent of the damage caused to fish in various locations of the Greek Seas and detect differences between them, their concentrations were determined in the flesh of red mullet, a quite abundant and commercially important fish species of the Greek Seas.

Fig. 1 : Map showing location of sampling stations (A : Alexandroupolis, B : Chios, C : Rhodos D : Canea, E : Preveza F : Aegina).

Samples were collected at six locations (Fig. 1) from 1988 to 1991. Organochlorine concentrations were determined according to the procedure proposed by SATSMADJIS *et al.*, (1988). GC analysis was performed by a GC equiped with a 63 Ni electron capture detector and a fused Silica DB-1 Megabore Column 30 m long (i.d. 0.53 mm) operating isothermally at 217°C.

The higher mean concentration of total PCBs (112.95 ppb) was found off Aegina Island (area F) and the lowest (4.4 ppb) off Rhodes Island (area C) (Fig. 2). The latter area, located in the southwestern Aegean Sea, exhibited also the lowest PCBs value during the 1986-1988 survey (GEORGAKOPOULOS-GREGORIADES and VASSILOPOULOU, 1990). The observed difference between the present PCBs value in area F and that in 1986-1988 could be possibly attributed to different sampling location; in 1986-1988 sampling took place in the SW part of Aegina Isle, whereas in 1989-1991 in the NE part of the island which is in the proximity of the Athens central sewage outfall. Areas F and C presented respectively the highest (8.05 ppb) and the lowest (3.3 ppb) DDTs values.



	A	B	C	D	E	F
PCBs	11.94	16.05	4.4	6.45	12.85	112.95
DDTs	21.22	24.19	8.05	12.82	16.54	27.4
HCHs	2.05	1.3	1.47	0.94	1.31	3.4

Fig. 2 : Mean concentrations of PCBs, DDTs, HCHs (ppb on a wet weight basis) in the flesh of red mullet in the six locations of the Greek seas

In all cases, the main component of DDTs was p,p'-DDE (Fig. 3), due to its higher persistence in relation to the other DDT metabolites (OLSSON, 1977). HCHs ranged from 3.4 ppb (area F) to 0.94 ppb (area D).

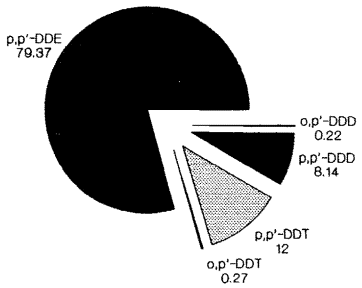


Fig.3 : Proportion % of the DDT metabolites in the flesh of red mullet.

The fact that the ratio PCBs/DDTs is less than 1 at the areas A, B, C, D, E possibly indicates that atmospheric transport is the main source of pollution, while at area F being 4.12, reveals the industrial origin of pollution, which was expected since the latter site is geographically close to the city of Athens and to the industrial zone of Elefsis.

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Biological responses of mussels transplanted in a heavy metal polluted environment of North Tyrrhenyan Sea

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Many studies have indicated that trace metal concentrations in mussels reflect the condition of the environment (review by PHILLIPS, 1980), and this is the reason why they are often chosen as "bioindicators" for monitoring programs.

It has also been outlined the importance of investigations on the biological effects of pollutants which could possibly relate the level of pollution in the environment with the health conditions of the organisms.

However, biological responses to heavy metals (such as accumulation and excretion, cellular and physiological effects..) have been usually studied in laboratory conditions and seldom in field experiments.

In this work, control mussels *Mytilus galloprovincialis*, obtained from a marine farm, were transplanted in plastic cages to a heavy metal polluted site of the North Thyrrhenian Sea (Scarlino), and removed by SCUBA diving at each sampling time.

Analysis of heavy metals revealed a strong accumulation in the digestive gland of transplanted mussels. After 1 week concentrations increased from less than 2 µg/g to 60 µg/g for Pb, from 19 to 100 µg/g for Mn, from 600 to 4000 µg/g for Fe. These high levels of metals in Scarlino are related to the presence of factories which produce sulphuric acid and titanium dioxide from pyrites and titanium minerals.

A "digestive gland index" was calculated as the ratio between digestive gland and shell weight. Variations of this d.g. index reflect changing digestive gland weight, shell being considered a much less variable parameter.

Figure 1 shows "d.g. index" in mussels from the farm and in those transplanted to Scarlino.

During the gametogenesis, the digestive gland is progressively penetrated by gonadal tissues, this determining the increase of digestive gland weight and, consequently, of the "d.g. index" observed in control mussels (Fig. 1A). This is confirmed by the fact that the highest values of the d.g. index were observed just before spawning period, when gonadal development is maximum.

The initial decrease of the "d.g. index" in transplanted mussels (Fig. 1B) indicates a loss of weight by this organ. This fact probably reflects the presence of defence mechanisms, such as a decrease of filtration rate, which reduce the exposure to metals (with obvious consequences on the nutritional state of the organisms), as well as the presence of a general stress induced by the environmental conditions.

The "d.g. index" resulted always lower in transplanted than in control mussel, this indicating the persistance of stress by heavy metals.

Furthermore, low values of the d.g. index in transplanted organisms also indicate a reduced gonadal development as a consequence of a low availability for gametogenesis of energy reserves which are rapidly utilized during stress period (THOMPSON *et al.*, 1974).

Responses to heavy metals were investigated also at the subcellular level where a severe disfunction of the lysosomal compartment was observed (REGOLI, 1992).

Transplanted mussels showed a reduced lysosomal membrane stability, the presence of enlarged secondary lysosomes and an enhanced production of lipofuscin in tertiary lysosomes.

These subcellular alterations as "early warning systems" can reveal a toxicity of pollutants before damages shift to higher levels of biological organization, and they could be used in monitoring programs as early biomarkers of stress.

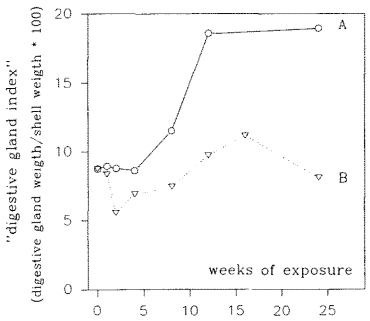

FIGURE 1

A) Control mussels
B) Transplanted mussels

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Heavy metal pollution in the Damietta Estuary of the Nile

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At the downstream of the Damietta branch, Faraskour's Dam was constructed separating it from the Damietta Estuary, which receives very small amounts of the Nile water. The average depth of the Damietta Estuary is 7 m and its width at the mouth does not exceed 200 m. The water quality of this Estuary was deteriorated due to pollution, mainly from sewage and industrial wastes. The present study deals with regional and seasonal variations of heavy metals in the Damietta Estuary to illustrate the impact of man on this water body. Water sampling was carried out seasonally during 1979-80 from the surface, middle and bottom waters at five selected stations.

Suspended matter (SM), ranging from 2.3-110.4 mg/l, showed irregular vertical variations. The surface increase in SM content resulted from settling of air-born dust. The bottom increase, however,coincided mainly with stirring up of the sediments by water currents. Such increase was matched with the corresponding increase in the bottom values of particulate heavy metals. The maximum regional average SM value was found at location directly affected by pollution, where dissolved and particulate metals gave maximum or markedly high average concentrations. The maximum seasonal average SM value in winter reflects the effect of strong wind in stirring up the sediments and rainfall in increasing land runoff (ABBAS, 1980). This highest SM content increased obviously the values of particulate metals, giving maxima or markedly high seasonal averages (Table 1).

The concentrations of iron varied widely from 2.16-46. 55 µg/l for dissolved form and from 1.80-406.8 µg/l for particulate form. The increase in the bottom dissolved iron coincided possibly with the increase in the rate of its release from sediments (SANDERS, 1970). Manganese concentrations varied considerably from 0.24-313.3 µg/l for dissolved form and from 1.6-191.1 µg/l for particulate form. Contrary to iron, the seasonal distribution of dissolved manganese reflects the role of phytoplankton uptake (Table 1). However, different pollutants could be considered as main sources for iron.

Copper concentrations varied markedly from 0.25-34.38 µg/l for dissolved form and from 0. 56-52.1 µg/l for particulate form. The minimum seasonal average value of dissolved copper in December was matched with the maximum seasonal average value of particulate copper (Table 1). These extremes in December were correlated with the increase in pH values (ABDEL-MOATI, 1981). The values of zinc varied markedly from 1.68-91. 88 µg/l for dissolved form and from 2.8-102.2 µg/l for particulate form. The increase in the bottom values of dissolved zinc may be attributed to sediment-water exchange of this metal (SONNEN, 1965). The highest regional average value of dissolved zinc matched with the lowest regional average value of particulate zinc was found at location, where reducing conditions prevailed (ABDEL-MOATI, 1981). Cadmium concentrations varied noticeably from 0.03-0.24 µg/l for dissolved form and from 0.04-1.93 µg/l for particulate form. The seasonal distribution of particulate cadmium was correlated with that of SM (Table 1). The increase in the mean values of SM and heavy metals calculated for the Damietta Estuary compared with the corresponding means of the comparatively clean Damietta branch reflects the influence of pollutants dumped in this Estuary.

		March 1	June 9	Sep. 7	Dec. 9	March 1980
SM		11.1	10.5	9.5	25.0	9.5
Fe	D	11.10	11.02	9.27	7.87	6.15
	P	183.2	96.4	106.0	147.2	109.7
Mn	D	16.36	8.64	23.27	55.14	14.6
	P	69.4	22.6	54.6	28.9	16.3
Cu	D	3.64	3.56	3.04	2.23	4.31
	P	8.5	9.2	8.5	11.8	10.3
Zn	D	17.24	6.87	14.99	15.39	13.35
	P	18.2	16.1	21.4	24.4	15.6
Cd	D	0.04	1.14	1.80	1.22	1.08
	P	0.26	0.19	0.16	0.36	0.16

D = Dissolved P = Particulate

Table 1. Variations of the seasonal averages of SM (mg/l), dissolved and particulate heavy metals (µg/l) in the Damietta Estuary of the Nile

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Distribution of nutrients in the Acheloos river mouth, Greece

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The study of chemical behaviour and cycling of nutrients in the estuary of Acheloos river is of high environmental importance for the follow reasons :

1. Acheloos is one of the largest Greek rivers (having a drainage area of 5350 Km^2 and a mean average flow of 167 $m^3.s^{-1}$).
2. The geomorphology of the estuary is different from that of other rivers due to the direct discharge of the river waters to the open sea. A very shallow sill exist at the river mouth.
3. Acheloos is among those rivers which are still considered as unpolluted, since it does not pass through heavily industrialized areas and it does not receive sewage and industrial effluents.
4. Some large hydroelectric dams play an important role in the fluctuation of its flow (particularly during the last 10 years) which does not follow a normal annual cycle.
5. A large scale divertion of part of the river water to Thessaly and Pinios river is planned for agricultural purposes. This project raised a series of serious environmental questions since the processes in the river and its mouth and their effects on ecosystems have not been adequately assessed.

A previous study (SCOULLOS *et al.*, 1985) in this area has shown that the river acts as a major source of inorganic nitrogen for the Patraikos Gulf mainly due to washout of fertilizers.

Methods

Eight seasonal samplings were carried out from 1984 to 1989 in an extended grid of stations in all parts of the system (river, estuary, sea). Hydro-bios plastic bottles were used for the collection of the samples and the nitrates, nitrites, ammonia, phosphates and silicates were measured by standard photometrical methods (STRICKLAND and PARSONS, 1972) after filtration of the samples. Dissolved oxygen, salinity, temperature and pH were also measured in situ.

Results and discussion

The observations of the preliminary study of the estuary were confirmed during this more detailed study.

The Acheloos river is a major source of nitrates and silicates in the adjacent sea area due also to the fact that some drainage canals discharge in it. These additions compensate the expected denitrification which could take place in the existing dams. High concentrations are more freequently found during winter when the values of nitrates and silicates in river waters exceed in some cases the level of 60µgat/l. The river contributes also ammonia and phosphates. The concentration of phosphates is usually smaller than 1µgat/l and that of ammonia ranges between 1 and 10 µgat/l. Nitrite concentrations were below 0.3µgat/l. The concentrations of all nutrients decrease in the sea outside the river plume.

Nitrates and silicates have the wider seasonal variations although ammonia and phosphates fluctuate also seasonally in a minor scale. Nitrates are the more abundand nitrogenous nutrient and the NO_3/NH_3 ratio which was practically >1, reaches values as high as >30 during winter.

The N/P ratio also varies and has usually values greater than 15:1, and in winter periods greater than 100:1. This might sugest that the phosphates are the limiting factor for the phytoplankton growth.

The behaviour of the nutrients in the intermixing zone of the estuary, as it concerns their conservativenes, changes seasonally, possibly due to biological activities. The main tendency is addition during winter and removal during summer.

Another interesting phenomenon observed in periods of minimum flow and mainly during summer months is the penetration of saline water inside the river bed and the formation of a thin salt wedge which occupies the near bottom layer of the water column with its thin end pointed up to 1-2 Km upstream. The reduction and control of the river flow by the dams is also responsible for this phenomenon which influences the behaviour and distribution of the nutrients. It is apparent that the position of the salinity front and the width of the intermixing zone fluctuates with time regulated mainly by the flow.

A typical distribution of salinity is shown in figure 1 and the corresponding distribution of nitrates is shown in figure 2. It is obvious that in the surface layer, as the fresh water is mixing with the saline downstream, the concentrations of nutrients decrease. In the near bottom saline layer the concentrations are smaller but an enrichment of nitrates and phosphates is observed inside the river and before the sill. This could partly be attributed to the degradation of the particulate organic matter (flocks etc) which is trapped and/or resuspended in the saline layer. Such profound enrichment at the bottom layer was not observed for silicates.

Figure 1 : Salinity, 6/1990

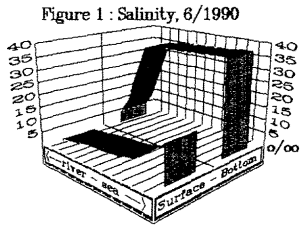
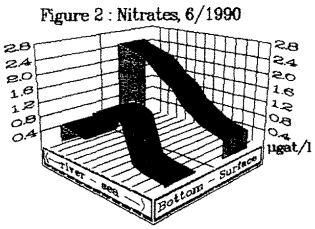


Figure 2 : Nitrates, 6/1990



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Particulate copper, lead and cadmium in Saronikos Gulf, Greece

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Trace metals have been studied thorougly in coastal areas of the Mediterannean. However the contribution of their particulate forms in marine pollution is still poorly understood. Saronikos Gulf, being in the vicinity of Athens, is an important area for the study of particulate metals which derive mainly from land based sources, namely, the Central Sewage Outfall (CSO) of Athens, direct industrial dishcharges and road traffic. In the northern part of the Gulf is located the enclosed Gulf of Elefsis, which receives high loads of metals by industrial activities.

Methods

Particulate Cu, Cd and Pb were studied on samples collected from an extended grid of stations that covered the entire area and water mass (to depths of 400 m) of the Gulf. Eight cruises, covered two annual cycles, carried out during June, September, December of 1988 and 1989 and March of 1989 and 1990. The water samples were collected by plastic Go-Flow bottles incorporated on a rosette system. The samples were filtered through prewashed and preweighted Millipore 0.45μm membrane filters, dried to constant weight, and treated with 1:1 aquatic solution of redistilled extra pure HNO_3 for 16 hr in covered PTFE beakers on a hot plate at 300°C. The solution was evaporated to near dryness, diluted with redistilled metal free water and quantitavely transfered to 50 ml prewashed polyethylene bottles. The final aliquots were analysed by a Perkin-Elmer 2380 GFAAS.

Results and Discussion

Cu : Higher concentrations were measured near the CSO and at the industrial zone of Elefsis. Lower values were found in the southern part of the Gulf. High concentrations were also measured during summer at the coasts of Elliniko and Vouliagmeni. A general decrease of concentrations was observed at greater depths with the exception of some deepest, near bottom, parts of the water column where the high suspended load is probably due to resuspension. No systematic trend was identified in the mean concentrations, during this relatively short two years period. However some extremely high values were observed in coastal samples. These values obviously influence the mean ones especially in March 1990 when high concentrations were found in a series of stations inside the Gulf of Elefsis.

Cd : In general with the exception of June 1988 and to a lesser extend September 1988, the concentrations were low with mean values below 0.01 μg/l. Clear systematic tendences were not observed as far as it concerns the sources of particulate Cd or their distributions with depth, a fact indicating important contribution by diffused sources and eventually significant atmospheric inputs.

Pb : High concentrations of lead were found along the industrial zone and CSO and near coastal areas with heavy traffic. The contribution of each source is variable with clear indication that traffic contributes more during summer and autumn. Extremely high values were observed in the gulf of Elefsis (9/88,3/90) and in the plume of the CSO (9/89). The surface concentrations were in general higher than those of the subsurface layers but some high values were also measured at the near bottom depths. No systematic trends were identified during the study period.

		Cu (ug/l)	Cd (ug/l)	Pb (ug/l)
6/88	range	0.09 - 1.25	0.001 - 4.6	<0.01 - 0.79
	mean	0.34	1.4	0.12
9/88	range	0.01 - 11.6	<0.001 - 0.33	<0.01 - 3.3
	mean	0.32	0.025	0.14
12/88	range	<0.01 - 0.6	<0.001 - 0.056	<0.01 - 0.13
	mean	0.10	0.005	0.02
3/89	range	<0.01 - 0.13	<0.001 - 0.004	<0.002 - 2.7
	mean	0.03	<0.001	0.08
6/89	range	<0.01 - 0.19	<0.001 - 0.072	<0.01 - 0.21
	mean	0.05	0.009	0.03
9/89	range	<0.01 - 0.43	0.001 - 0.019	<0.01 - 0.17
	mean	0.10	0.004	0.05
12/89	range	<0.01 - 2.8	0.001 - 0.044	0.01 - 0.20
	mean	0.15	0.013	0.07
3/90	range	0.01 - 16	0.001 - 0.155	0.03 - 2.9
	mean	1.90	0.012	0.36

General observations

The study of particulate trace metals in the Saronikos gulf showed that they contribute considerably to its pollution. Main sources are the CSO, the industrial zone, the coastal traffic and runoff, as well as the ships. The important variations in particulate metal inputs are due to the effect of rainfalls and meteorological conditions and also to the intensive "patchy" planktonic blooms which are important to contribute to the high metal concentrations found at the surface layers. The highest values were measured near the point land based sources. The water circulation and atmospheric inputs influence the distribution of metals throughout the area. The concentrations at the southern part of the Saronikos were relatively low compared to values reported for other polluted areas of the Mediterranean.

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Effects of cadmium on the physiology and chemical composition of the green algae *Ulva rigida* (C. Ag.)

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The green algae of the genus Ulva are among the species commonly found in polluted and eutrophicated coastal marine areas. In sea waters with high nutrient concentrations *Ulva* sp. have exhibited increased growth rates and elevated mineral nutrient content in their tissues[2]. It was also found during field and laboratory experiments that they demonstrate the ability to accumulate heavy metals, when exposed to high concentrations[3]. Therefore they can play a significant role in the food chain as well as in the biological and physicochemical transfer of metals from seawater to sediments[4].

The present study is part of an ongoing program with the principal aim to investigate the effects of different concentrations of heavy metals on the physiology and chemical composition of *Ulva rigida*, and understand the mechanism of uptake and release of metals.

Ulva rigida atoms were collected from a polluted bay near Athens (Gulf of Elefsis). The specimens were treated with increased concentration of cadmium (200 ppb) for 15 days[5]. The water was replenished every day with new quantities of cadmium enriched seawater from the same area. Individual algae were removed after 1,2,4,7 and 15 days and their cadmium content was determined by Atomic Absorption Spectrophotometry[6]. Portions of the samples removed, were kept for different periods of time in clean seawater (6 and 15 days), and at the end of these periods the remaining cadmium content was measured (see Table 1).

It was found that the metal uptake is faster during the first days of the exposure to high cadmium concentrations. Usual concentrations in algae ranged from 21.71 to 111.34 μg/g dry weight. When placed in clean seawater the alga releases most of the accumulated metal within the first 6 days. The remaining amount of metal depends on the originally accumulated quantity but never reaches the metal content of the untreated algae which is around 0.06 μg/g d.w.

It is known from the literature that *Ulva* sp. are rich sources of sterols and glycoproteins[7]. The production of chemicals during the metal treatment period, was used as an indicator of the algal physical condition. Unexposed algal samples as well as specimens treated with cadmium (200 ppb), were taken, air dried and extracted with organic solvents (chloroform/methanol). The extracts were concentrated under vacuum, and the residue was dissolved in ethyl acetate. Solutions of known concentration (10 mg/ml) were prepared and chromatographed by High Pressure Liquid Chromatography (Techsil 110sil column with a gradient hexane/ethyl acetate solvent system).

It was observed that the two chromatographs exhibited some marked differences. The organic extract of the treated algae showed the presense of some intense peaks (Techsil 110sil column with a gradient 70% hexane, 30% ethyl acetate --- 10% hexane, 90% ethyl acetate, 30 min. run, 2 ml/min, UV 254 nm detector) eg. peaks with retention time 6.93, 9.10, 9.40, 13.64 min. absent in the extract of the unexposed to cadmium samples. From the aforementioned results, we can assume that, under the intense stress conditions caused by the increased cadmium concentration, some metabolic processes in the algae were altered. This is the result of chemical adaptability observed also in other marine organisms when exposed to modified environmental conditions.

Table 1

Sampling days	Days in clean seawater	Metal content of the algal tissue (μg/g dw)
1	0	21.71
	6	5.23
	15	30.34
	0	24.72
2	6	6.85
	15	4.16
4	0	36.64
7	0	73.86
	6	11.43
	15	10.02
15	0	111.34

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L

Hydrocarbures polyaromatiques dans le sédiment superficiel des Côtes Ouest de l'Algérie

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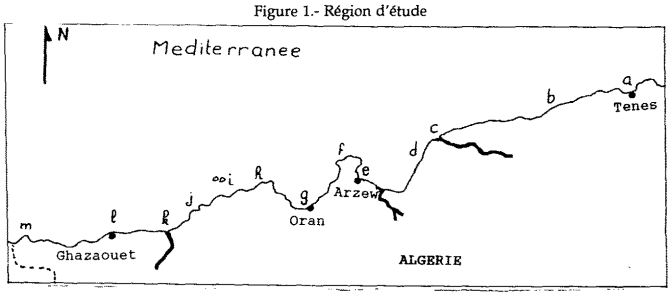
Introduction.

Dans cette étude, nous présentons les résultats portant sur l'évaluation du degré de contamination des sédiments de la côte ouest de l'Algérie par les hydrocarbures polyaromatiques (HPA (fig.1). Les méthodes de traitement des échantillons sont celle décrites par IOC (1982). L'analyse est menée par spectrofluorimétrie ultra-violet; les résultats sont exprimés en équivalents chrysène e rapportés au sédiment sec. l'interétalonnage est réalisé sur c sédiment lyophilisé fourni par l'AIEA (Monaco) et codé SDK_1/PH. L région d'étude a été subdivisée en 4 zones : Tenes; Arzew; Oran, Ghazaouet.

Figure 1.- Région d'étude



Résultats et discussion. (Tableau.1)

Tenes: Les taux relevés (1.613 ± 0.366)µg/g indiquent un contamination hétérogène de la zone, néanmoins les vases semblent plu contaminées. Les spectres synchronisés montrent la prédominance de composés à 2, 3 et 4 noyaux condensés (>70 %); les HPA à 5 noyaux son toujours présents à des taux > 15 %. La source pétrolière es effective dans la zone, cela n'élimine cependant pas les source pyrolytiques et diagéniques.

Arzew: Les importantes activités pétrochimiques présentes dans un golfe contribuent clairement à l'enrichissement des sédiments en HP particulièrement dans le secteur occidental (1.858 - 28.835 µg/g). La source pétrolière est identifiée par l'abondance des produits à 2 et 4 noyaux condensés (DUJMOV et SUCEVIC, 1990). L'existence d'un incinérateur à même la plage se traduit par un taux important en composés à 5 noyaux condensés (SIMONEIT, 1985).

Oran: Si l'on exclue les îles Habibas (i, qui répondent au caractéristiques d'un secteur non pollué (0.087 ± 0.01 µg/g), cette zone semble être affectée par les apports urbains de la ville d'Oran et ses environs. Les taux relevées en composés à 2, 3 et 4 noyau polyaromatiques reflètent la contamination élevée par les produit pétroliers. Les sources pyrolytiques et diagéniques demeurent présentes.

Ghazaouet: L'influence des localités qui bordent la frange littorale est relativement faible par rapport au reste de la région d'étude; des pics de pollution sont néanmoins perceptibles à Beni-Saf (j) (1.23 ± 0.33 µg/g) et Merset Ben-M'hidi (m) (1.35 ± 1.22 µg/g). Cette contamination est probablement liée au trafic maritime.

Tableau 1

ZONE		HPA(µg/g)	1Noyau(%)	2Noyaux(%)	3&4Noyaux(%)	5&+Noyaux(%)
Tenes						
	a	1,354	8,436	34,906	39,163	17,953
	b	1,873	4,126	42,07	37,196	16,603
Arzew						
	c	1,746	8,48	41,543	39,12	10,843
	d	2,116	6,79	53,023	33,903	6,243
	e	12,179	6,083	31,12	35,563	27,226
	f	0,922	6,3	40,61	43,12	9,96
Oran						
	g	2,368	7,79	37,233	35,883	19,086
	h	1,283	5,325	36,01	37,925	20,74
	i	0,087	11,085	30,43	39,53	18,955
Ghazaouet						
	j	1,23	9,343	44,903	34,05	11,696
	k	0,61	15,32	52,64	23,053	8,983
	l	0,761	8,64	59	24,303	8,05
	m	1,355	6,62	43,38	29,347	20,142

Conclusion.

Si des zones telles que le Golfe d'Arzew présentent déjà des niveaux critiques, des sites non pollués ont été recensés. En définitive, la répartition spatiale des HPA dans cette région est déterminée par l'influence de facteurs multiples et complexes, tel que la proximité des sites urbains et industriels, l'intensité du trafic maritime, l'hydrodynamisme, la texture du sédiment...

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Suspended particulate matter as a marine pollutant vehicle The Case Study of the Rasa River Estuary (Istra, Croatia)

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A major problem of coastal and marine pollution are land-based sources. Next to the hydraulic transport, the most important vehicle are suspended mineral particles. This study of the Rasa River estuary (Istra, Croatia) follows previous investigations of the Krka River, a typical karstic estuary (JURACIC and PRAVDIC, 1991), and of the much more important and larger Adige River mouth (BOLDRIN *et al.*, 1989). The Rasa River is more interesting due to a larger mineral particles load originating from clastic flysch rocks, to activities such as coal mining and burning in the nearby power plants, and because of port facilities and intensive agriculture in the upper reaches of the river.

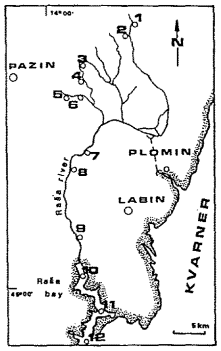

Figure: The Rasa River estuary sampling stations

The Rasa River is a comparatively small river, typically karstic and reflecting the seasonal variations of the Adriatic. Its mean flux in the upper part, at the sampling station (ST 7), measured in the span of some 15 years is 2.3 m^3/s (with a range from 0.1 to 43), whereas additional sources and bottom wells increase this mean flux to 12 m^3/s at the river mouth. The water samples taken in September 1991 had the following concentrations of particulates: 1.2 mg/dm^3 (ST 9 surface) and 29.2 mg/dm^3 (ST 9 near bottom, at -3 m); 17.0 mg/dm^3 (ST 10 surface) and 46.6 mg/dm^3 (ST 10 near bottom, -16 m).

The characterization of sediments included : organic matter estimation by oxidative stripping ; nitrogen adsorption BET specific surface area determination (SSA) ; and the determination of cation exchange capacity (CEC) using NH_4 exchange from 1 mol/dm^3 ammonium acetate and estimation by ammonia specific electrode. A review of results is given in the Table 1.

TABLE 1: ***Characteristics of samples***

	Sampling station	SSA m^2/g native	SSA m^2/g treated	CEC meqv/100g native	CEC meqv/100g treated	organic matter (%)	Pb (ppm)	Cd (ppm)
	2	16.1	10.9	19	20	3.0	59	6
I	3	14.8	14.6	54	57	3.2	93	9
	5	15.6	8.2	29	24	3.2	72	8
	4	24.0	26.5	78	103	5.0	118	12
	6	14.6	15.0	49	87	1.7	72	8
II	7	24.6	25.5	50	85	6.9	-	3
	8	32.6	30.5	74	86	7.5	115	16
	9	11.3	8.7	32	31	6.7	230	22
III	10	10.2	10.0	42	23	4.8	107	12
	11	14.0	13.3	26	35	5.4	132	12
IV		2.0		9				

Legend : I - source rocks (marls); II - river sediments; III - estuarine sediments (seawater influence); IV - coal particles extracted from sea sediment, sample 10.

The amount of organics is modest, the SSA rather high and there is little change observed on removing organics. This is indicative of particles where the mineral core is the dominant factor governing adsorption. The exchange capacities reflect the presence of carbonates.

Coal particles have been detected in marine sediments, originating from coal mines in the area. Such particles have been extracted mechanically from the sediments. These have very small surface areas, and very low CECs. These preliminary results indicate that most of the pollutant transport capacity will be due to clay minerals, and that the influence of coal particles might be minor.

The analysis on lead and cadmium bound to particles (ICP AES - Jobin Yvon P-50) show that these metals are progresively accumulated downstream, with the maximum at station 9, where the salt wedge is found at prevalent hydrologic conditions. Calculations show that Pb takes up less than 3% of the CEC of sediment particles.

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Heavy metals in seawater and surface sediments of the Gulf of Bourgas

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The Gulf of Bourgas is one of the highly polluted regions of the Black-sea coasts. The pollutants include petroleum products as well as heavy metals. The pollution is due to the geomorphological charateristics of the gulf as well as the presence of a large number of chemical industries in the vicinity of the sea. The investigations on the heavy metals present in the sea-water and the surface sediment are rather scarce. Therefore such a study is useful.

In May and September, 1991, samples were done from the sea water and the surface sediment at three different stations : namely Bourgas Port (I), Petroleum Port (II) and the bulk of the gulf (III). The samples were analysed for the concentrations of Cd, Cu, Pb and Zn by a suitable electroanalytical method.

The sediments were collected from the surface by mechanical drilling, dried at a temperature of 105° C, grinded and fractioned. A preweighed dry sample (d < 0.06 mm) was dissolved in HCl (purified by isothermal distillation) on heating in a closed container at 250°C for 10 h, filtered out and analysed by a polarographic method with standard addition (1). The completeness of the extraction process was controlled by the atomic emission spectral analysis of the insoluble residue.

The Pb content was determined directly in the filtrate. A part of the solution was evaporated to complete drying, then dissolved in excess NH_3 and filtered again. Cu, Cd and Zn contents in a samplewere determined simultaneously The half-wave potentials of the elements under these conditions were respectively -0.3V, -0.8V and -1.4V vs SCE.

The samples from the sea water were collected in plastic bottles pretreated with HNO_3 and filtered through a membrane filter (pore-diameter < 0.45 μ). In order to eliminate organic impurities, the samples were subjected to electrochemical anodic oxidation at + 1.4 V for 10 min. in a graphite container.

The mentioned heavy metals in the sea-water were determined by a method of anodic stripping voltametry (ASV) [2] under the following conditions : stripping process on HMDE at 1.2V vs SCE for 10 min., deoxidation with N_2 and anodic dissolution of the deposited impurities at a rate of 400 mV/min. The metals under investigation show well-defined sigle peaks and their concentrations were determined by a method of standard addition.

Table 1. - Heavy metals in sea-water (sw), mg/l and sediments (sed) mg/g dw

Station	elements	Cu		Zn		Cd		Pb	
	month	V	IX	V	IX	V	IX	V	IX
I	sw	10.3	11.2	9.3	9.9	0.25	0.23	0.05	0.05
	sed	93.4	99.9	52.4	53.3	3.70	3.90	73.40	78.80
II	sw	15.1	16.8	10.4	10.5	0.28	0.30	0.06	0.07
	sed	115.2	107.6	53.3	61.4	4.80	4.70	79.50	78.10
III	sw	8.7	9.1	10.1	12.0	0.21	0.23	0.04	0.07
	sed	82.2	82.1	50.8	52.2	3.60	3.70	70.40	73.30

* The mentioned concentrations are the averages of 6 parallel measurements.

The experimental results show that the concentrations of Cu and Cd at station II are the highest - a fact most probably attributed to the presence of Copper mine nearby. The Pb concentrations is comparatively higher at the stations I and II, however Zn concentration is almost constant . Although no general conclusions can be drawn for the seasonal changes in the heavy metal contents, it may be noted that in September (IX), their concentrations are higher than in May (V). There exists some correlation between the heavy metal contents in the sediments and that in the corresponding sea-water. Due to the limited number of investigations, the obtained data for the concentrations show the relative pollution in the investigated regions of the gulf .

The electrochemical methods proposed for the analysis of Cu, Cd, Pb and Zn are rapid, sensitive and selective. Relative standard deviation for the polarographic determination is 2-5 % and that for ASV is 8-12 % (n = 6).

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Effects of pollution on the physiology of *Callianassa tyrrhena* (Crustacea : Decapoda) from Saronikos gulf

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This study concerns the effect of pollution on the physiology of the decapod crustacean *Callianassa tyrrhena*, which is a widely distributed callianassid along the european coast of the Mediterranean and is present in coastal polluted and non polluted areas of the Saronikos gulf (gulf of Athens). This species forms dense populations on sand flats and its influence on redox potential and nutrient cycling of the sediment has been documented by OTT*et al.* (1976). Its ecology and biology in greek seas has been the subject of some recent studies (THESSALOU-LEGAKI, 1988, 1990).

The physiological condition of the organisms was examined by means of a dual approach : metabolic (respiration rate) and enzymatic, in order to obtain a pluridimentional view of the effects of pollution at the physiological level.

Two sampling areas were chosen : Elefsis bay (eutrophic, one of the most polluted areas in the eastern Mediterranean) and Vouliagmeni bay and Fleves Islands (oligotrophic, non polluted area). Animals were collected from the shore of both areas during spring and summer 1991, using a hand-operated pump.

In each sample, males, ovigerous and non-ovigerous females were immediately selected and the individuals were placed separately. Animals were then divided into two groups. The first one was preserved in a freezer (-25°C) and transported by air to Marseille (France) in a dry ice container for the enzymatic tests. The API-ZYM system (Bio-Merieux, France) was used as a semiquantitative micromethod to test the enzymatic activity of 19 hydrolases from digestive gland extracts. Oxygen consumption both on individual (total respiration rate) and per biomass unit (weight-specific respiration rate) basis was measured from the second group using a dissolved oxygen meter (YSI model 51B) according to OMORI and IKEDA (1984). Dry weight of the individuals was determined only in a few cases directly (for 72h at 70°C) while for the majority of the specimens it was calculated from length-weight relationships that already existed (THESSALOU-LEGAKI, 1988). The statistical treatment of the results was mainly based on a multifactor analysis of variance taking into account the relationships between the respiration rate and the season, the locality, the sex (males, ovigerous and non ovigerous females) and the dry weight.

From the biochemical point of view, the results showed a large individual variability according to the physiological state of each specimen. Figure 1 gives the comparative mean enzymatic activities observed by the API-ZYM technique in males and non ovigerous females from the two areas. A statistically significant increase was observed in the total respiration rate with increase of the dry weight, whereas the weight-specific respiration rate decreased significantly with increasing individual dry weight ($P<0.001$). A seasonal variation was also observed ($P=0.01$): the mean total respiration rate was 70.5±5.2μl in spring and 55.5±3.7μl $O_2.ind^{-1}.hr^{-1}$ in summer. No statistically significant variation was found in the total respiration rate regarding sex, locality as well all the interactions of the factors concerned. A significant geographical variation was observed for the weight-specific respiration rate ($P=0.05$): 0.12+0.01μl $O_2.mg\ DW^{-1}\ hr^{-1}$ for specimens from Elefsis bay, and 0.20±0.02μl $O_2.mg\ DW^{-1}.hr^{-1}$ for those from Vouliagrneni.

The results obtained both by enzymatic tests and respiration experiments, show that *C. tyrrhena* exhibits different physiological behavior according to sampling areas. As hydrolases are acting mainly on substrates provided by the environment, the differences observed for most of them may be attributed to the trophic conditions of the sampling areas. Therefore, they appear to be an ecophysiological response to the environmental conditions. Out of the 19 enzymes tested, only 3 exhibit a higher activity in Elefsis than in Vouliagmeni specimens.

The general tendency is, therefore, an "inhibitory" effect of the pollution on enzymatic activities. Such observations are in agreement with several literature data (AMIARD *et al.*, 1982; RIVIERE et KERAMBRUN, 1983) and may be related to the benthic way of life, which is more directly affected by pollution.

As far as respiration metabolism is concerned, season and locality significantly affect total and weight-specific respiration rate respectively : the total respiration rate of the individuals collected in summer is about 1.3 times lower than those collected in spring while the animals of the non polluted area (Vouliagmeni) have a two times higher weight-specific respiration rate than those of the polluted eutrophic area (Elefsis bay).

The low rates of respiration of *C. tyrrhena* obtained from the present study are in good agreement with the literature data concerning thalassinids from coastal or intertidal sediments, the respiration rates of which are among the lowest observed for decapods. This is interpreted as an adaptation allowing them to maintain aerobic respiration even in almost anoxic conditions. The decrease in the activity of digestive enzymes agrees with this interpretation and suggests that the whole metabolism is involved in the adaptation to pollution.

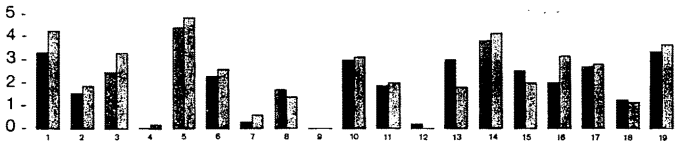

Figure 1. *Callianassa tyrrhena*. Comparative enzymatic activities mean obtained from API- ZYM (arbitrary units from 0 to 5). Dark : Elefsis bay samples; Light: Fleves islands samples.
1, acid phosphatase; 2, esterase (C4); 3, esterase lipase (C8); 4, lipase (C14); 5, leucine arylamidase ; 6, valine arylamidase; 7, cystine arylamidase; 8, trypsine; 9, α-chymotrypsine; 10, acid phosphatase; 11, phosphoamidase; 12, α-galactosidase; 13, β-galactosidase; 14, β-glucuronidase; 15, α-glucosidase; 16, β-glucosidase; 17, N-acetyl-β-glucosaminidase; 18, α-mannosidase; 19, α-fucosidase

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Heavy metals and other elements in *Zostera marina* L. on the Trabzon Coast Line (Black Sea; Turkey)

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The marine phanerogam *Zostera marina* forms vast beds was found along the Black Sea coastline at depths rarely exceeding 5-20 m. It has been studied that importance of the diversity and abondance of sea grass comes from their role as primary producers and they have a very important role in detritus formation. They constitute also a natural resource that must not only be protected but also investigated, assessed and managed.

In addition that in previous papers (TUNCER, 1988, 1989) the abilities of *Z.marina, Posidonia oceanica* and some algae were accumulated some heavy metals from sea water.

Eeel grass *Zostera marina* were collected by Scuba diving the period between June and August 1991 in the Sana coastline (Trabzon) at a depht of 16-18 m. in homogeneous beds. This area is affected by domestic and some hydrocarbons wastes coming directly from pumping stations and harbour activities.

All materials were brought to the laboratory, the epiphytes were scraped off, and samples were oven-dired for 24 hr at 105°C, then leaves and shoots (15-20 g. D. W) were mineralised in Pyrex vessels with $HNO_3 : HClO_4$ (5 : 1) under the reflux. Each sample was made in triplicate, filtered and assayed using AAS for heavy metal analysis.

Some principal elemental composition has also been analysed by Spectrometry, Colorimetry and Kjeldall.

All the mean results were summarized in Table I.

Table I. Some Heavy metal and Elemental Composition in the Marine Phanerogam *Zostera marina*.

Element	Symbol	Unit	Leaves	Shoots
Cadmium	Cd	ppm	1.05	1.05
Calcium	Ca	%	1.08	2.58
Chromium	Cr	ppm	1.52	2.20
Cobalt	Co	ppm	3.04	3.14
Copper	Cu	ppm	0.84	0.60
Iron	Fe	mg/g	9.37	0.51
Lead	Pb	ppm	1.17	3.14
Magnesium	Mg	%	0.12	0.27
Manganese	Mn	ppm	138.40	91.60
Nickel	Ni	ppm	4.80	3.56
Nitrogen	N	%	1.65	0.92
Potassium	K	%	1.24	1.10
Phosphate	P	%	0.20	0.23
Sodium	Na	%	2.10	2.16
Zinc	Zn	ppm	3.63	23.22

According to our present results, the levels of element concentration vary among the leaves, and shoots. Our data, are in conformitly with (GRAUBY *et al.*, 1991) in a marina phanerogam *Posidonia oceanica*. Some of heavy metals Fe, Zn, Cu, Pb and Cd used in antifouling paints was applied to boats, and it may be considered that contamination of *Z.marina* is directly related with these metals (BYRAN, 1976). There is a need for further investigation into the other species.

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A Comparative Study on Cr_{tot} Concentrations of Water, Sediments and Some Benthic Organisms of Izmir Bay

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The discharge and dumping of sewage and industrial spoils had released significant quantities of heavy metals in Izmir Bay. Some of these industries such as chemistry, fertilizier, paper, painting, plastics, iron and steel, textile especially well established leather and tinning has been well known as responsible of increased chromium concentration in aquatic environment (IRPTC 1978, KESTIOGLU and SENGUL, 1984). In this investigation chromium content of sediment, water and some benthic organisms collected from Izmir Bay between Dec. 1989 - Dec. 1990 from 11 sampling stations (Fig. 1), has been determined considering with the transportation processes of heavy metals in marine environment.

Water samples were prepared for analyse by solvent extraction technique using APDC-chloroform (KINRADE and VANLOON, 1974). Sediment samples were dried at 110°C for 24 hours and 1 gr of dried samples were wet ashed with $HNO_3 : HClO_4$ (1:5). Biological samples were also digested with $HNO_3 : HClO_4$ (1:5) (FAO Technical Paper No:158).Cr_{tot} content of the samples were determined using Pye-Unicam Model SP9. AAS with flame technique supported by acetilen-NO_2 fuel.

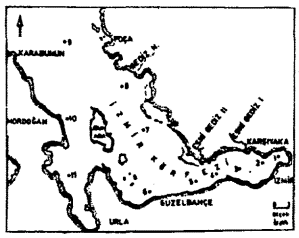

Figure 1. Sampling stations

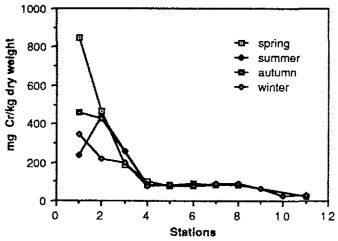

Figure 2. Cr_{tot} concentrations of sediment samples

According to the results of this investigation, there were strong enrichment of Cr_{tot} in sediments of Izmir Bay. Precipitation processes of high organic and inorganic suspended matter which may adsorbe chromium from seawater, gives rise to chromium content of sediment while chromium concentration of sea water is considerably low. The Cr_{tot} concentration in sediment ranged between 26.753-471.150 mg Cr_{tot} kg^{-1} dry weight. It has also apparent that inner bay has the greatest Cr_{tot} content (Fig 2). Literature review shows that Cr_{tot} concentrations of sediment has increased gradually from Sept. 1986 to Sept. 1990 (ALYANAK, 1989, USLU, 1990). It means that Cr_{tot} input to inner bay is a continuous problem.

Cr_{tot} content of sea water were ranged between 5.5-8.5 µg Cr_{tot} l^{-1} with average 7.7 µg Cr_{tot} l^{-1} (Fig. 3).This average value were considerably high as two fold of clean waters of Mediterranean (JEANDEL and MINSTER, 1987; SENGUL and MUEZZINOGLU, 1982; USLU, 1986). On the other hand, this average Cr_{tot} content were comparable with the results of SCOULLOS *et al.* 1982, who obtained 6.6 µg Cr_{tot} l^{-1} from the samples of Gulf Gera (Greece).

Average Cr_{tot} concentrations of muscle of some demersal fish such as *S.vulgaris, A.laterna, G.niger* and *B.luteum* were determined. *S.vulgaris* had a maximum value in outer by (station number 8) with 663.3 µgCr_{tot} kg^{-1} while lower in inner bay as 257.5 µgCr_{tot} kg^{-1} (Fig.4). Cr_{tot} concent of *B. luteum*, were range between 458.8-198.2 µg Cr_{tot} kg^{-1} while the concentration of were 176.3-1215.0 and of *G.niger* were 132.2-1493.0 µg Cr_{tot} kg^{-1}. Concentration factors of *S.vulgaris, B.luteum, A.laterna, G.niger* were 549.7, 502.7, 708.4, 627.1 respectively.

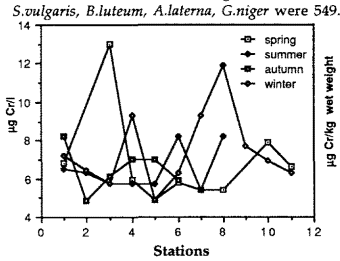

Figure 3. Cr_{tot} concentrations in sea water

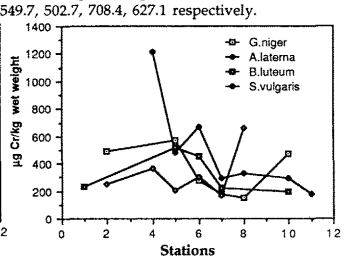

Figure 4. Cr_{tot} concentrations of some demersal fish

Also, *D.annuiaris, S.alcedo* and *S.scriba* had 382.4, 210.9, 219.0 µg Cr_{tot} kg^{-1} but they were not enough in number to have statistical considerations . Some these values were comparable to the values obtained from the demersal fish sample of Gera bay (Greece) such as 435 µg Cr_{tot} kg^{-1} for *D.annularis*, but some of then were quite low (such as *S.scriba* 35, *S.alcedo* 53 µg Cr_{tot} kg^{-1}) comparing to our results (GRIMANIS *et al.*, 1980).

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Heavy metal concentrations in selected marine species from fisheries bays of Aegean coast

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As indicated before Aegean coastline is long and has a large number of fishery areas, Bay and Estuaries (UYSAL, 1980; DEMIRKURT *et al.*, 1990). Due to increased industrial, touristic, urban and agricultural activities important quantities of chemical pollutants are entering our coasts from different sources. Those waste disposals are affecting the ever increasing portion of our bays of coastal regions. The pollution results in a demunition of edible organisms and decrease in the quality of marine life. It also effects human health through food chain. For this reason, the knowledge of levels of pollutants in edible marine organisms is important for the public health (ANDREOTIS and PAPADOPPOLOU, 1982). However, in recent years considerable amount of work has been carried out in relation to the accumulation and distribution of heavy metals in the marine biota (BEI *et al.*, 1990). The purpose of this survey is to determine the level of heavy metals (Cu,Mn,Zn,Fe,Pb,Cd) in selected species in polluted and unpolluted part of our Aegean coasts.

In this study the samples considered are *Tapes decussatus* L. *Patella* Spp, *Mytilus galloprovincialis* Lam, *Cardium edule* L., *Sepia officinalis* L., *Natica millepunctata* Lam., *Mugil* Spp, *Solea vulgaris vulgaris*, (QUENSEL, 1804), *Anguilla anguilla* L., *Diplodus annularis* L., *Dicentrarchus labrax* L., *Ulva* Spp., *Enteromorpha* Spp, *Cladophora* Spp. These were collected from different polluted coastal regions (especially İzmir Bay and its vicinity) (Fig. 1).

All samples were wet digested with HNO_3, $HClO_4$ (5:1) and HCl, by heating on a hot-plate and analysed by using "Varian Techtron Atomic Absorption Flame Spectrophotometer Model 1250".

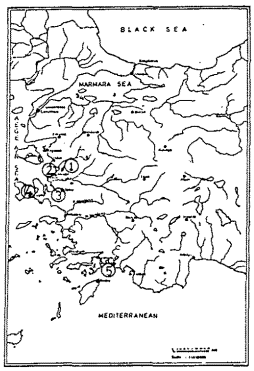

Figure 1. Sampling side a long in Aegean coast line

The concentration of each heavy metals was determined separetely in selected marine species in the different sampling areas from our coasts (Fig.l, Table 1). As can be seen from the table too, the heavy metal concentrations show variations depending on the species and locality. In general the levels of heavy metal concentration are as follows : Fe>Zn>Cu>Mn>Pb>Cd.

There are still nontoxic levels in the mentioned species that could be dangerous to the consumers, but it will be better to continue periodically the regional comperative survey on the pollution effects on the representative indicator species of the different marine biotops for the benefit of public health.

Our present results have been varified and the values obtained are within acceptable limits when compared with those other parts of the Aegean Sea (UYSAL, 1980, BEI *et al.*, 1990). However, heavy metal levels of mentioned food chain organisms may not be taken into account for today, but in the very near future it's alarming that there will be some hazardous conditions if more effective and serious legislations would not be held urgently.

Table 1. The levels of heavy metals which were determined in some edible marine species collected from Aegean coasts (µg/g Dry Weight)

	Species	Dry weight %	Cu	Mn	Zn	Fe	Pb	Cd
1 Aliağa Bay	Tapes decussatus L.	18.8	4.556	7.874	113.38	268.50	1.417	2.362
	Mytilus galloprovincialis L.	18.6	2.260	4.785	162.67	118.18	2.153	0.478
	Patella spp.	28.9	2.638	5.838	93.46	731.50	1.227	1.252
	Sepia officinalis L.	23.7	0.655	0.328	26.56	12.90	0.197	0.328
	Natica millepunctata	18.0	11.700	3.000	131.00	106.00	1.800	1.000
	Ulva spp.	17.2	2.946	8.298	21.57	223.23	1.493	0.415
	Enteromorpha spp.	23.3	0.810	7.044	9.89	415.93	0.295	0.046
2 Foça Bay	Patella spp.	18.7	2.773	21.048	42.57	800.00	1.758	0.781
	Ulva spp.	22.0	1.556	31.456	19.86	264.90	0.596	0.662
	Enteromorpha spp.	25.4	2.789	35.882	35.54	462.99	0.612	0.170
3 İzmir Bay	Tapes decussatus L.	17.6	4.112	9.412	44.70	131.76	3.176	2.352
	Patella spp.	22.6	3.699	14.121	79.09	583.00	1.323	1.244
Homa Fishery	Mytilus galloprovincialis L.	15.2	5.959	18.413	2995	107.67	1.849	1.369
	Cardium edule L.	18.9	2.439	87.046	103.10	375.13	2.332	0.518
	Sepia officinalis	23.4	6.428	2.143	21.42	15.71	1.285	0.357
	Solea solea vulgaris Q		1.185	1.546	17.01	22.68	0.927	0.515
	Mugil spp.	23.3	1.478	1.747	12.17	16.11	0.533	0.387
	Diplodus annularis L.		1.041	1.357	17.20	12.67	0.407	0.452
	Ulva spp.	14.3	1.298	6.104	9.10	1718.95	0.537	0.448
	Enteromorpha spp.	13.5	2.333	52.708	35.17	583.33	1.333	0.416
Çalıburnu fishery	Tapes decussatus L.	17.7	1.520	4.360	82.97	146.28	1.960	0.436
Deniz Boğazlısı	Tapes decussatus L.	12.3	3.032	5.161	85.81	121.29	0.581	1.935
	Ulva spp.	21.7	4.700	13.000	98.60	958.00	2.700	3.000
Çakalburnu Fishery	Tapes decussatus L.	20.0	2.850	4.830	83.80	384.73	0.869	0.242
Sahilevleri (İncirallı)	Venus verrucosa L.	17.5	1.628	8.492	142.34	640.02	2.54	1.365
Kalabak	Patella spp.	19.6	4.259	59.26	51.85	544.44	5.000	5.555
	Enteromorpha spp	14.0	0.691	6.323	17.20	222.10	0.529	0.147
Urla iskele	Patella spp.	25.7	2.149	7.476	61.68	119.25	2.523	2.803
Karaburun	Patella spp.	28.4	1.783	4.651	74.42	810.00	1.395	7.751
	Ulva spp.	13.0	15.535	14.184	14.89	1096.09	2.553	0.709
4 Çeşme Harbour	Patella spp.	14.0	3.833	13.333	93.33	281.50	4.500	5.000
	Ulva spp.	11.3	10.682	19.318	29.54	1331.82	3.068	3.409
	Enteromorpha spp.	12.7	11.848	32.203	44.54	286.89	3.715	2.521
Kuşadası	Enteromorpha spp.		2.011	3.940	9.65	183.86	1.580	0.877
5 Köyceğiz Fishery	Mugil (Liza) ramada	21.7	1.326	29.392	16.88	31.69	0.636	0.422
	Diplodus annularis	25.5	0.950	2.066	19.42	1.612	0.743	0.826
	Dicentrarcus labrax	20.1	0.744	49.51	18.12	12.62	1.16 5	0.647
	Anguilla anguilla L.	21.4	0.926	67.10	53.85	51.46	1.432	0.265
	Cladophora spp.		9.168	5.093	35.14	669.13	0.764	0.679
	Enteromorpha spp.		0.695	81.64	28.52	983.34	1.711	1.901

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Détermination de l'apport de sels nutritifs et de polluants par des cours d'eau au milieu marin côtier : Cas de la baie de Monaco

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Les vallons de la Principauté de Monaco et de son arrière-pays sont drainés par quatre cours d'eau à régime torrentiel dont les débits sont élevés seulement en période de pluie (la Noix, la Rousse, Saint-Roman, Sainte-Devote).

Les paramètres chimiques suivants ont été déterminés à intervalles réguliers d'août 1988 à décembre 1990 dans les eaux de ces torrents, à proximité de leurs embouchures : sels azotés (nitrates, nitrites, ammonium), phosphates, silicates, détergents anioniques, matières en suspension totales (MEST), demande biochimique en oxygène (DBO5) et métaux lourds (Cu, Pb, Cd, Hg). Des mesures de débit en continu ont également été effectuées à l'aide de débitmètres placés aux points de prélèvements. Les sels azotés, les phosphates, les silicates et les détergents ont été déterminés au moyen d'un analyseur à flux continu (Technicon). La DBO5 a été déterminée selon la méthode normalisée AFNOR (par dilution). Le dosage des métaux lourds a été effectué par spectroscopie d'absorption atomique.

Les valeurs des flux annuels de sels nutritifs et de polluants estimés pour 1989 et 1990 à partir des débits et des concentrations mesurés sont données dans le Tableau 1. Les valeurs indiquées doivent être considérées comme des ordres de grandeur seulement car le nombre réduit de mesures (un prélèvement par mois environ) et leur forte dispersion introduit une grande incertitude dans le calcul des moyennes. Il est cependant possible de constater que dans la majorité des cas les charges polluantes sont plus élevées en 1989 qu'en 1990, et ceci quel que soit le torrent considéré. Cette différence est probablement due aux variations des débits moyens des torrents d'une année à l'autre. Les concentrations des polluants ayant en genéral tendance à augmenter avec les débits, il en résulte des valeurs plus élevées pour les flux estimés pendant les périodes de fort débit. A l'exception du torrent de la Rousse qui présente des valeurs de débit moyen et de flux d'ammonium, de phosphates et de MEST plus fortes en 1990 qu'en 1989, les débits moyens et les charges polluantes ont diminué de manière appréciable entre 1989 et 1990. Les valeurs indiquées au Tableau 1 montrent également que c'est le torrent de la Rousse qui, d'une manière générale, apporte le plus de polluants à la baie de Monaco.

Un haut degré de corrélation ($r = 0,998$, $p < 0,001$) a été trouvé entre les flux mesurés de MEST, azote total, phosphore et métaux lourds et les flux qui peuvent être calculés d'après les valeurs des débits annuels des torrents et les données de la littérature relatives à l'introduction de ces substances, par les fleuves et les rivières, dans la Méditerranée nord-occidentale (1, 2, 3).

TABLEAU 1

ESTIMATION DES FLUX ANNUELS DE SELS NUTRITIFS ET DE POLLUANTS

SEL NUT. POLLUANT	ANNEE	FLUX ANNUEL DU TORRENT			
		STE. DEVOTE	LA NOIX	LA ROUSSE	ST.ROMAN
NH4	1989	854 Kg/an	56 Kg/an	615 Kg/an	42 Kg/an
	1990	27 Kg/an	13 Kg/an	6,0 T/an	19 Kg/an
NO3	1989	11,7 T/an	20,1 T/an	11,9 T/an	10,8 T/an
	1990	6,5 T/an	5,2 T/an	7,6 T/an	1,4 T/an
NO2	1989	286 Kg/an	68 Kg/an	159 Kg/an	103 Kg/an
	1990	26 Kg/an	10 Kg/an	69 Kg/an	6 Kg/an
PO4	1989	1,8 T/an	35 Kg/an	1,1 T/an	215 Kg/an
	1990	102 Kg/an	15 Kg/an	5,7 T/an	103 Kg/an
SiOH4	1989	6,4 T/an	5,7 T/an	9,5 T/an	4,8 T/an
	1990	2,7 T/an	2.4 T/an	7,8 T/an	1,6 T/an
DET	1989	1,1 T/an	42 Kg/an	1,5 T/an	58 Kg/an
	1990	17 Kg/an	2 Kg/an	893 Kg/an	25 Kg/an
MEST	1989	39,3 T/an	9,3 T/an	119 T/an	4,9 T/an
	1990	146 T/an	1,3 T/an	280 T/an	530 Kg/an
DBO5	1989	19,6 T/an	690 Kg/an	28,8 T/an	1,0 T/an
	1990	411 Kg/an	255 Kg/an	20,3 T/an	449 Kg/an
Cu	1989	5 Kg/an	959 g/an	26 Kg/an	3 Kg/an
	1990	1 Kg/an	542 g/an	2 Kg/an	610 g/an
Pb	1989	8 Kg/an	2 Kg/an	18 Kg/an	2 Kg/an
	1990	2 Kg/an	1 Kg/an	973 g/an	249 g/an
Cd	1989	115 g/an	31 g/an	218 g/an	42 g/an
	1990	20 g/an	26 g/an	51 g/an	9 g/an
Hg	1989	< 45 g/an	< 48 g/an	< 55 g/an	< 47 g/an
	1990	< 18 g/an	< 27 g/an	< 67 g/an	< 18 g/an
Débit moyen	1989	0,008 m3/s	0,012 m3/s	0,011 m3/s	0,012 m3/s
	1990	0,005 m3/s	0,004 m3/s	0,018 m3/s	0,005 m3/s

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Effects of pollution on the physiology of *Acartia clausi* and total zooplankton from Saronikos Gulf

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A study of the influence of pollution on the physiology of the crustacean copepod *Acartia clausi* and total zooplankton was carried out in coastal polluted and non polluted areas of the Saronikos Gulf (Gulf of Athens). The physiological situation of the organisms was examined by means of a dual approach : metabolic (respiration rate) and enzymatic in order to obtain a pluridimensional view of the effects of pollution on coastal zooplankton at the physiological level. The copepod species, *Acartia clausi*, was chosen as one of the basic elements of the zooplanktonic community of the Saronikos Gulf (MORAITOU-APOSTOLOPOULOU, 1974).

Two sampling areas were chosen : Elefsis bay (eutrophic, one of the most polluted areas in the eastern Mediterranean) and Vouliagmeni bay and Fleves islands (oligotrophic, non polluted area). Several samples were collected in both areas during spring and summer 1991. After transport to the laboratory, one zooplankton sample was used to select two or more sets of mature specimens of alive *Acartia clausi* (100 ind., 200 ind. when possible). The other total zooplankton samples and the sets of selected *A. clausi* were divided into two groups. The first one was preserved in a freezer (- 25°C) and transported by air to Marseille (France) in a dry ice container for electrophoresis and enzymatic tests. Oxygen consumption and dry weight were measured from the second group.

Electrophoresis were carried out on 7,5% polyacrylamide gel using a Tris-Glycine buffer pH 8,5. Several enzymatic activities were revealed. The API-ZYM system (Bio-Mérieux, France) was used as a semiquantitative micromethod to test enzymatic activity of 19 hydrolases. Oxygen consumption measurements were carried out using an oxymeter (YSI model 51 B) according to OMORI and IKEDA (1984). The statistical analysis of the results were based mainly on a multifactor analysis of variance, taking into account the respiration rate and the presence or absence of food during the experiment, the season and the locality.

Figures 1 and 2 show the differences observed in *A. clausi* and total zooplankton zymograms of esterases and amylase between the two sampling areas. Figure 3 gives the comparative activities of 19 hydrolases tested by the API-ZYM technique in the total zooplankton from the two areas.

Mean oxygen consumption rate for *A. clausi* was 5.9 ± 0.7 µl O_2. mg $DW^{-1}.hr^{-1}$ in spring and 3.1 ± 0.9 µl O_2. mg DW^{-1}. hr^{-1} in summer. This seasonal variation was statistically significant (P= 0.02). A geographical variation was also observed : the copepods of the non polluted area (Vouliagmeni-Fleves) had a higher respiration rate (5.6 ± 1.0 µl O_2. mg DW^{-1} hr^{-1} than those of the polluted eutrophic area of Elefsis bay (3.5 ± 0.7 µl O_2. mg DW^{-1} hr^{-1}). But the difference was only significant at the probability level P = 0.06.

No statistically significant variation was observed in the respiration rate of starved and fed *Acartia* collected at different seasons and in the two areas. Nevertheless, the variability induced by the absence of food was greater in *Acartia* from Vouliagmeni-Fleves than in those from Elefsis bay. The seasonal variation was also greater in *Acartia* from Vouliagmeni-Fleves.

The results, either concerning respiration metabolism or enzymatic activities, show that physiological differences exist either in *A. clausi* or total zooplankton according to the area concerned, the very polluted, eutrophic Elefsis bay, and the non polluted oligotrophic area of Vouliagmeni-Fleves.

Enzymes tested are essentially hydrolases acting on substrates provided by the environment. The differences in the activity observed for most of them according to the origin of the organisms, thus may be attributed to the trophic conditions of the sampling areas. Therefore, they appear to be an ecophysiological response to environmental conditions (RIVIERE et KERAMBRUN, 1983). The major tendency is a generally higher enzymatic activity in the zooplankton from Elefsis bay. In *A. clausi*, among the few enzymes whose activity appears to be greater at Fleves, we can only take into consideration alkaline phosphatase and amylase. In the case of *A. clausi*, the pollution of Elefsis bay seems to have an "activatory" effect on most of the enzymatic systems tested.

The respiration rate of *A. clausi* showed a clear geographical and seasonal variation in the metabolism. Copepods from the polluted, eutrophic area (Elefsis bay) have a lower respiration rate than those of the non polluted, oligotrophic area (Vouliagmeni-Fleves). Respiration rate also decreases by about 50% from spring to summer in *Acartia* from Vouliagmeni whereas this decrease is lower in polluted waters.

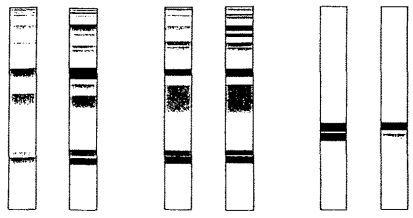

Fig. 1. Acartia clausi. Zymograms of esterases. Sample from Fleves on the left; from Elefsis on the right.

Fig. 2. Total zooplankton. A, zymograms of esterases; B, zymograms of amylase. In both cases, sample from Fleves on the left, from Elefsis on the right.

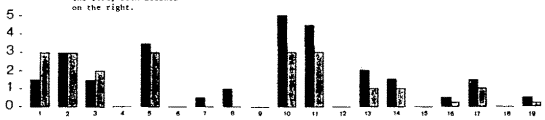

Figure 3. *Acartia clausi*. Comparative enzymatic activities mean obtained from API- ZYM (arbitrary units from 0 to 5). Dark: Elefsis bay samples; Light: Fleves islands samples.
1, acid phosphatase; 2, esterase (C4); 3, esterase lipase (C8); 4, lipase (C14); 5, leucine arylamidase; 6, valine arylamidase; 7, cystine arylamidase; 8, trypsine; 9, α-chymotrypsine; 10, acid phosphatase; 11, phosphoamidase; 12, α-galactosidase; 13,β-galactosidase; 14,β-glucuronidase; 15, α-glucosidase; 16,β-glucosidase; 17, N-acetyl-β-glucosaminidase; 18, α-mannosidase; 19, α-fucosidase

Literature data indicate that the population of *A. clausi* of Elefsis bay is adapted to pollution (MORAITOU-APOSTOLOPOULOU et VERRIOPOULOS, 1979, 1981 a, b). Our results, both concerning enzyme activity and respiration rate, show that the differences observed between sampling areas seems to be directly linked to the degree of water pollution, which influences ecophysiological relationships, thus affecting general metabolism.

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Heavy metal concentrations in the Kerkyra Strait (N.E. Ionian Sea)

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Kerkyra Island is situated in the uppermost Northeastern part of the Ionian Sea. The study area is located between the Kerkyra Island and the Northwestern part of Greece. It communicates with the Ionian Sea through two straits: 1 n.m. wide in the North, 6 n.m. in the South; maximum width of the area 16 n.m. (Fig.1). The depth contours generally follow the coastal lines, and maxima of around 70 m are attained in the central part of the region. There is a shallow (<20 m) embayment north of the Kalamas River Delta.

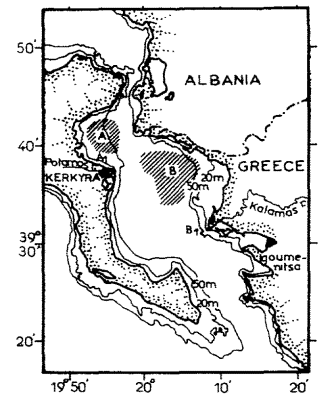

Table I : The study area, the bathymetry and the areas mentionned in the text.

The main interest of the study is focused in the marine environment around the city of Kerkyra, with a permanent population of 40.000 inhabitants and over 100.000 tourists a year. The study area receives agricultural and industrial wastes brought by the Kalamas River and some by a small torrent north of the city of Kerkyra. The goal of this study is to assess the environmental state of the region, as far as heavy metal pollution is concerned, and to answer to questions related to the impact of the domestic waste disposal through a central sewage outfall system, which will be constructed soon.

Surface sediment samples were collected during 3 cruises in 1990-91 over a grid of 102 stations, using a 0.1 m2 van Veen grab. The sample network was particularly dense in the sea area off the city of Kerkyra.The samples were examined for organic carbon and the metals Fe, Cr, Ni, Mn, Zn, Co, Cu and Pb.

The extraction of the metals was achieved with 2N HCl and the determination of the metal content in the leachates was performed on a Perkin-Elmer 305 B A.A.S. (SATSMADJIS & VOUTSINOU-TALIADOURI 1981). Organic carbon was obtained according to GAUDETTE, *et al.*, 1974. Analyses were performed in triplicate. The reliability of the whole process had been ascertained in Intercalibration Exercises (I.A.E.A., 1978). The analyses indicated the following average standard deviations and coefficient of variations: Fe (%0) 0.85, 4.4; Mn ($mgkg^{-1}$) 38, 5.0; Zn ($mgkg^{-1}$) 4.3, 7.2; Cr ($mgkg^{-1}$) 3.8, 3.4; Ni ($mgkg^{-1}$) 3.3, 4.1; Co ($mgkg^{-1}$) 0.9, 8.2; Cu ($mgkg^{-1}$) 1.1, 4.8; Pb ($mgkg^{-1}$) 0.8, 6.7.

The mean values of the analyses are depicted in Tables I & II. Most organic carbon values range from 0.4 to 1.1% and do not indicate any anthropogenic input.

Heavy metal concentrations are generally low and depict almost the same ranges as those obtained, with similar methodology, in other Greek coastal unpolluted regions (Table I).

Table I : Heavy metal concentrations in Greek coastal unpolluted regions (Data for East Aegean Sea, Amvrakikos Bay, South Euboekos Gulf, Lesvos Island, Messolonghi Lagoon, Milos Island, Navarino Bay and Pagassitikos Gulf from VOUTSINOU-TALIADOURI, 1988)

Area	Fe (%)	Cr	Ni	Mn	Zn	Co	Cu	Pb
	(----------	ppm	----------	)				
Kerkyra Isl.	**0.70-3.40**	**35-257**	**65-190**	**200-1400**	**21-94**	**2-24**	**7-30**	**8-24**
East Aegean S.	1.40-3.00	52-157	39-291	280-2640	25-55	8-24	4-29	11-22
Amvrakikos B.	0.49-3.05	27-177	33-188	323-3820	12-80	4-30	2-31	7-21
S.Euboekos G.	0.60-1.50	37- 90	25-144	165- 555	25-44	4-15	0-40	12-27
Lesvos Island	0.32-2.10	40-247	20-315	172-1126	18-43	0-19	3-12	10-39
Messolonghi L.	1.00-2.80	56-112	40-112	470-1380	30-80	6-16	8-34	6-17
Milos Island	0.30-0.60	10- 19	6- 21	113- 251	15-18	2- 4	2- 4	2- 7
Navarino Bay	0.20-3.00	12-251	8-123	243- 600	7-81	4-15	0-32	2-28
Pagassitikos G.	1.30-3.00	50-186	32-228	290-2790	38-72	8-22	9-25	19-30

In general, heavy metal concentrations display the same distribution pattern: four regions with slightly enhanced concentrations.

i) area A: (Fig.1) the enrichment factors of the metal concentrations in this area range from 1.47 to 2.07 (Table II); **ii) area B:** the enrichment factors of the metal concentrations (except Pb) range from 1.10 to 1.70; **iii) area A1** (at the mouth of the torrent Potamos): the concentrations of Pb and Cu are slightly elevated and **iv) area B1** (at the mouth of the Kalamas River): the concentrations of Cu, Co and Cr are slightly elevated.

Table II: Heavy metal enrichment factors in the study area.

	Fe	Cr	Ni	Mn	Zn	Co	Cu	Pb
Area A	1.85	1.62	1.47	1.75	1.70	1.60	2.07	1.50
Area A_1	-	-	-	-	1.10	-	1.23	1.33
Area B	1.22	1.10	1.10	1.70	1.10	1.20	1.24	-
Area B_1	-	1.32	-	-	-	1.60	2.00	-

The slight enrichment in heavy metal concentrations encountered in areas A and B (covered by fine-grained sediment) is attributed to the physicochemical processes of the material supplied by the nearby rivers. In conclusion, surface sediments of the study area show heavy metal concentrations similar to those reported for other unpolluted Greek areas, although a slight anthropogenic enrichment of the concentrations of Cu, Co, Cr and Pb at the mouth of the rivers is sustained.

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State of pollution of the Turkish coast of the Eastern Mediterranean by land based sources

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Following the development of the regional seas programmes for protection of the Mediterranean Sea against pollution (UNEP, 1982 ; UNEP, 1985), the member countries have spent more effort to reduce the waste discharges and to assess the present level of pollution in the receiving marine environment as well as for determining the annual loads of hazardous pollutants given to the coastal waters of the Mediterrranean.

It is important to note that there have been a great migration from the eastern and inland areas towards the Aegean and Mediterranean coasts of Turkey-extending from Iskenderun to Izmir-resulting in uncontrolled population increase and serious problems in relation to environmental pollution during the last decades. The industrial establishments preferring to locate at the coast and especially the coastline between Mersin and Iskenderum in the Northeastern Mediterranean region (Figure 1) is intensively industrilized (e.g. iron and steel, textile, food, paint, soda, pulp and paper, ferro-chrome, plastic, artificial fertilizer and petroleum industries). In this article, the pollutional status of the NE Mediterranean coastal waters from land-based sources is presented from the data of 9 years (1983-1991). The parameters monitored at the main sewage outlets, rivers and industrial discharge points were, Total Suspended Sediment (TSS), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Feacal Coliform (FC), Poliaromatic Petroleum Hydrocarbons (PAH) and Nutrients (PO_4 -P, Total-P, NO_3+NO_2 and Total-N) and the average values are given in Table 1. The concentration levels of these parameters were checked at the nearest coastal stations and at three offshore stations (Fig. 1). The annual loads of these pollutants from land-based sources were estimated and compared with the other Mediterranean regions. On the regional basis, Iskenderun and Mersin are the most polluted regions relative to western coastal waters. (YILMAZ *et al.*, 1992). The Bay of Iskenderun for example receives 85 x 10^3 tons of BOD, 525 x10^3 tons of COD annually where as the Mersin Bay receives 15 x 10^3 tons of BOD and 132 x 10^3 tons of COD. Consequently there may be potential danger for local ecosystem in this corner of Eastern Mediterranean. The western regions of Northeastern Mediterranean of Turkey, extending from Anamur to Marmaris are the least affected regions from the wastwater discharges.

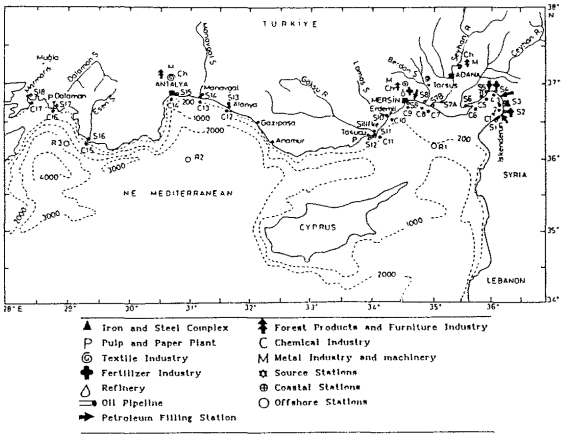

Figure 1. Locations of rivers, industrial and domestic inputs and coastal, offshore stations included in the pollution source inventory in the Northeastern Mediterranean.

Station	TSS (mg/L)	BOD5 (mg/L)	COD (mg/L)	FC #of cells/100mL	PAH µg/L
Iskenderun Sewage (S1)	88.5	62.4	199.5	1072.8x10^3	13.3
Sarisekl Fertilize. (S2)	691.3	5.9	56.7	-	1.2
Iron and Steel Complex (S3-A) (Residental area)	11.8	32.2	150.9	42.2x10^3	33.6
Iron and Steel Complex (S3-B) (Industry)	381.5	10.9	61.4	-	271.6
Toros Fertilizer (Acidic Effluent)(S4-A)	1633.4	13.1	108.3	-	27.6
(Basic Effluent) (S4-B)	138.3	2.4	106.5	-	120.0
Botas Oil Pipe line (S5)	3.5	-	-	-	19.5
Ceyhan River (S6)	280.1	4.6	24.4	5.6x10^3	5.7
Seyhan River (S7-A)	19.3	6.9	48.0	29.6x10^3	7.3
Adana Sewage (S7-B)	27.1	33.9	233.7	206x10^3	43.3
Berdan Stream (S8)	25.2	3.9	11.4	5.0x10^3	4.2
Mersin Sewage (S9)	51.6	71.2	414.8	9360x10^3	51.7
Goksu River (S11)	134.7	1.5	22.2	0.8x10^3	1.4
Pulp and paper Industry (S12)	51.1	120.0	215.0	-	51.0
Manavgat Stream (S14)	15.2	2.9	8.4	0.2x10^3	0.6
Antalya Sewage (S15)	12.9	187.5	300.6	143.3x10^3	1.4

Table 1. Overall average of some pollutants measured at selected discharge points in the Northeastern Mediterranean.

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Heavy metal resistance of bacteria isolated from marine environments - Critical concentrations to determine resistance or sensitivity -

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Introduction.

Bacterial strains resistant to heavy metals have been isolated from different marine environments. Resistance or sensitivity of microorganisms to heavy metals are clearly determined by the assayed concentration of metals, but there are not generally accepted criteria for selecting these concentrations. The purpose of this study is to propose appropriate critical concentrations of metals to determine the threshold of resistance or sensitivity of microorganisms isolated from marine environments.

Material and Methods.

Bacterial strains were isolated from samples of water, sediments and shellfish. These samples were collected from the marine area near the Guadalhorce river mouth and on beaches affected by sewage discharges in Malaga (Spain). The resistance to heavy metals was studied in isolates of coliforms, fecal streptococci, *Pseudomonas aeruginosa*, *Salmonella* serotypes, *Aeromonas hydrophila*, *Vibrio* spp. and *Staphylococcus* spp. by using the agar dilution method (4). The minimal inhibitory concentration (MIC) was determined by testing twofold serial dilutions of $HgCl_2$, Na_2AsO_4H, K_2CrO_4, $CdCl_2$, $CuCl_2$, $NiCl_2$, $Pb(CH_3\text{-}COO)_2$) and $ZnS0_4$.

Results and Discussion.

The distribution of MIC for Cu, Ni, Zn, and Pb are very narrow (800-1600 µg/ml of $CuCl_2$, $NiCl_2$, and $ZnS0_4$, and 6400-25600 µg/ml of $Pb(CH_3\text{-}C00)_2$), nearly all the strains studied present the same two or three MIC values. However, the distribution of MIC values for As, Cd, Cr, and Hg show a wider range (Figure 1). A bimodal distribution for the MIC values of As and Hg is observed, so 12800 µg/ml of $Na2AsO_4$ and 10 µg/ml of $HgCl_2$ are the critical concentrations proposed to determine the resistance or sensitivity to As and Hg, respectively. On the other hand, MIC distributions with only one peak are observed for Cd and Cr; for this, it is difficult to establish the critical concentration. However, 400-800 µg/ml of $CdCl_2$ and 800 µg/ml of K_2CrO_4 could be appropriate values, because at those MICs a decrease in the frequency of resistant strains is observed. In Table 1, the critical concentrations proposed in this work are compared with those proposed by other authors.

Table 1. Critical concentrations (µg/ml) of metals to determine resistance/sensitivity of bacteria isolated from marine environment.

Na_2AsO_4H	$CdCl_2$	K_2CrO_4	$HgCl_2$	Reference
	100	100	10	Austin *et al.*, 1977
-	11	-	5	Timoney *et al.*, 1978
-	10-60	-	-	Gauthier *et al.*, 1986
12800	400-800	800	10	This study

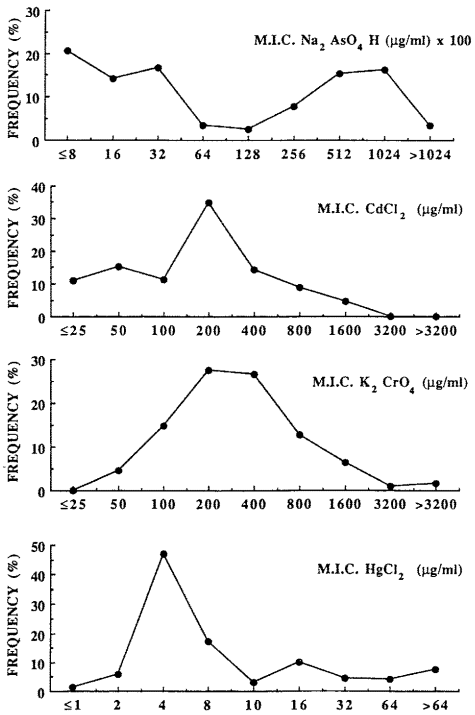

Fig. 1.- M.I.C. distribution of heavy metals observed in bacterial strains isolated from marine environments

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Distribution of bacterial plasmids in marine environments

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Introduction.

Plasmid carriage is an adaptative advantage for microorganisms, so the percentage of plasmid carrying microorganisms is expected to be higher in polluted environments (3).

Likewise, it is largely accepted that bacterial strains harbouring plasmids are more frequent in environments exposed to certain pollutants or stress factors (4,5).

Material and Methods.

Samples of water, shellfish and sediments were collected in the marine area near the Gualdalhorce river mouth in Malaga (Spain). These samples showed three different ranges of heavy metal concentrations (1) with the highest levels in sediments and the lowest in water. The microorganisms studied belong to two groups: fecal pollution indicators (Coliforms and Fecal Streptococci) and pathogens (*Pseudomonas aeruginosa*, *Salmonella* serotypes, *Aeromonas hydrophila*, *Vibrio* spp. and *Staphylococcus* spp.). The culture media employed for the isolation of microorganisms were: Endo agar, KF agar, Cetrimide agar, XLD agar, mA agar, TCBS agar and Mannitol salt agar for each microbial group, respectively. Plasmid content was analyzed using a modified alkaline-SDS procedure and electrophoresis on agarose gels (6).

Results and Discussion.

The results obtained are summarized in Tables 1 and 2, which show the frequencies of plasmid detection in relation to fecal pollution levels and to the isolation sources, respectively. A statistical test of the difference in proportions of bacteria containing plasmids in each environment was performed (3).

Globally, higher detection frequencies were observed in fecally polluted zones (A and C) with regard to those wich show the lowest levels of pollution (B) (Table 1). *A. hydrophila* and *Vibrio* show higher frequencies of plasmid harbouring strains in the areas more highly polluted; however, a clear relation of the fecal pollution level and the occurrence of plasmid carrying microorganisms is not observed, when the other bacterial groups are considered. These results are in disagreement with those reported by other authors, who have observed higher frequencies of strains of *P. aeruginosa* and coliforms with plasmids in highly polluted zones (2,3).

The highest frequencies of plasmid harbouring strains were observed in shellfish samples and the lowest in the isolates from seawater. Although significant differences were obtained for the plasmid occurrence with relation to the isolation source of microorganisms (Table 2), these differences were not related to the concentrations of heavy metals. These results are in accordance with BURTON *et al.* (3), who studied the plasmid content of heterotrophic microorganisms isolated from clean and polluted environments.

Table 1. Frequency of plasmid detection related to the fecal pollution level.

	Zone B		Zone C		Zone A		TOTAL	
	n	%	n	%	n	%	n	%
P. aeruginosa	1	100	6	33.3	11	45.4	18	44.4
Coliforms	5	80.0	7	100	9	77.8	21	85.7
Salmonella	1	100	1	0.0	3	33.3	5	40.0
A. hydrophila	1	0.0	5	60.0	12	75.0	18	66.7
Vibrio	4	0.0	-	-	11	45.5	15	33.3
Staphylococcus	1	0.0	3	66.7	2	50.0	6	50.0
Fecal streptococci	7	71.4	3	33.3	10	70.0	20	65.0
TOTAL	20	55.0	25	60.0	58	60.3	103	59.2

Table 2. Frequency of plasmid detection related to the isolation source.

	Water		Shellfish		Sediment		TOTAL	
	n	%	n	%	n	%	n	%
P. aeruginosa	11	45.5	5	60.0	2	0.0	18	44.4
Coliforms	9	88.9	8	87.5	4	75.0	21	85.7
Salmonella	3	33.3	1	100	1	0.0	5	40.0
A. hydrophila	6	50.0	7	71.4	5	80.0	18	66.7
Vibrio	3	0.0	4	50.0	8	37.5	15	33.3
Staphylococcus	5	60.0	1	0.0	-	-	6	50.0
Fecal streptococci	5	40.0	5	60.0	10	80.0	20	65.0
TOTAL	42	52.4	31	67.7	30	60.0	103	59.2

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M

Analyse cyclique des variations des indicateurs de pollution et des germes pathogènes dans une zone côtière polluée

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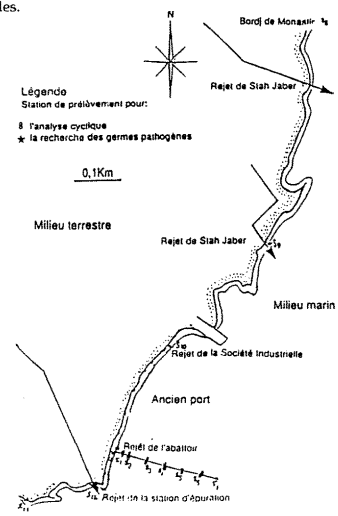
Nous nous sommes intéressés ici à la recherche et au dénombrement des coliformes totaux CT, des coliformes fécaux CF et des germes totaux aérobies, mésophiles GAM et cultivables sur gélose nutritive, au cours d'une année dans les stations réparties sur la figure 1. Cette analyse cyclique a été faite simultanément pour les coliformes et les germes pathogènes dans l'objectif de dégager les relations éventuelles entre ces germes. Nous avons pu donc d'abord délimiter la région la plus polluée et la saison où cette pollution est la plus prononcée. Dans une seconde étape et en nous basant sur les résultats obtenus, nous avons essayé de calculer le coefficient de corrélation entre les différents paramètres déterminés. L'analyse des variations de ces coefficients a été faite en fonction des saisons et des stations.

Les résultats du dénombrement montrent que les valeurs maximales sont obtenues dans les stations les plus proches du point de rejet (S1 et S2) et les valeurs minimales sont obtenues dans les stations les plus éloignées de ce point (S6 et S7). Les GAM présentent un maximum de densité en été, alors que les CT et CF présentent le taux le plus élevé a la fin de la période hivernale et au début du printemps. Les tracés de la courbe de Bonde montrent que seules les stations 1 et 2 sont constamment polluées, les stations 3 et 4 sont faiblement polluées, les stations 5, 6 et 7 ne sont pas polluées et peuvent servir de stations témoins. Pour évaluer la relation entre les GAM dans toutes les stations durant toute l'année, nous avons déterminé le coefficient de corrélation (R) entre toutes les valeurs obtenues. La même étude a été faite avec les CT et CF. Nous avons déterminé aussi les coefficients de corrélation entre les GAM et les CT d'une part, entre les GAM et les CF d'autre part, et enfin entre les CT et les CF. L'influence de la distance au point de rejet sur les trois groupes de germes étudiés (GAM, CT, CF) dépend des groupes eux-mêmes: des effets différents s'excercent sur les groupes hétérogènes particulièrement les GAM (R faible ou négatif) et, en contre partie, des effets comparables ont été obtenus sur les CF (R voisin ou supérieur à 0,9) d'où p est supérieur à 95 %. L'effet des saisons sur les relations entre les GAM, les CT et les CF dans les trois groupes des stations: stations polluées (S1, S2), peu polluées (S3 et S4) et non polluées (témoins) S5, S6 et S7 montre que les coefficients R obtenus dépendent largement des saisons et des groupes considérés. Cela confirme une fois de plus que les facteurs de stress du milieu marin n'agissent pas de façon identique sur les bactéries. Dans les stations polluées, on remarque une corrélation positive entre les trois groupes de germes dans les stations polluées (S1, S2) particulièrement en hiver et en automne. Cette corrélation est plus faible au printemps et en été dans ces mêmes stations. Dans les stations non polluées : la corrélation entre les GAM et CT est bonne durant le printemps, l'été et l'automne mais elle est nettement plus faible en hiver.

La corrélation entre les GAM et les CF est importante en hiver et en automne, moyenne, en été et change de signe au printemps. Entre les CT et CF la corrélation dépend aussi des saisons. La recherche des germes pathogènes a été faite durant deux années, les prélèvements d'eau ont été faits régulièrement, chaque semaine, 460 prélèvements ont été réalisés dans les stations représentées sur la figure 1. Aucune *Shigella*, aucun *Vibrio cholerae* n'ont été trouvés. Trois souches de *Salmonella paratyphi* B ont été détectées. *Pseudomonas aeruginosa* germe pathogène opportuniste a été le plus fréquemment isolé particulièrement au printemps.

Nous avons effectué des prélèvements réguliers de crabes, de patelles et d'oursins dans les stations S8, S9, S10, S11 et S12. Le nombre total d'animaux analysés est de: 537 crabes, 275 patelles et 119 oursins. Les souches de salmonelles trouvées dans l'eau ont été retrouvées dans les crabes. Le nombre de germes pathogènes trouvés dans l'eau et chez les invertébrés de la région Sud-Est de Monastir s'avère relativement faible par rapport au taux de contamination mesuré par le dénombrement des CF. De ce fait il n'est pas possible d'établir une corrélation entre ces germes pathogènes et les indicateurs de pollution. MUNIZ *et al.*, (1989), travaillant sur les eaux douces tropicales ont noté que "le meilleur indicateur des pathogènes c'est qu'il n'y ait pas d'indicateur du tout". LECLERC *et al.* (1983) ont montré au cours des analyses d'eaux de consommation que le nombre des coliformes fécaux déterminé par incubation à 44,5°C ne tient pas compte des CF qui ne se développent pas bien à cette température. Ils ont donc suggéré qu'il serait préférable de réaliser cette incubation à 41°C. Il en résulte alors que le nombre des CF que nous avons déterminé est faible par rapport à ce qui existe en eau de mer.

La rareté des germes pathogènes détectés au cours de ce travail peut s'expliquer alors (i) par l'absence de relation entre ces germes pathogènes et les indicateurs de pollution comme mentionné dans le cas des eaux douces tropicales (MUNIZ *et al.*, 1989), ce qui n'est pas encore démontré dans le cas des eaux marines (ii) par l'inadéquation des techniques de recherche et d'identification utilisées au cours de ce travail, bien qu'étant parmi les plus classiques et les plus standardisées. L'évolution récente de la microbiologie marine à la suite de la mise en évidence des formes atypiques et non cultivables des germes entériques met en question la plupart des résultats d'analyses microbiologiques des eaux qui ne s' intéressent qu'aux formes typiques et cultivables.



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Modifications des caractères de *Salmonella wien* au cours de son séjour en eau de mer

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Les salmonelles, fréquentes en milieu hospitalier et chez les porteurs sains, sont souvent véhiculées et rejetées dans la mer avec les eaux usées. Dans ce milieu nous avons pu montrer que *S.paratyphi* B subit des modifications très profondes et donne des formes masquées difficiles à retrouver par les techniques classiques de recherche de *Salmonella* (BAKHROUF *et al.* 1990). *Escherichia coli* évolue aussi en eau de mer vers des formes non cultivables sur les milieux de culture utilisés pour sa recherche (GAUTHIER *et al.*, 1990). Nous rapportons ici les résultats des travaux faits sur une souche de *S.wien* qui était isolée à l'Institut Pasteur de Tunis chez un porteur sain.

Le suivi de la survie de cette souche en flacon d'eau de mer a permis de voir que cette salmonelle peut survivre plus d'une année en eau de mer. Elle subit des modifications plus ou moins profondes selon la durée d'incubation en eau de mer. Sur des galeries Api 20E, l'arginine dihydrolase positive chez la souche parentale devient négative chez les colonies transparentes obtenues sur gélose nutritive (GN) après 20 jours de mise en contact avec l'eau de mer . Chez toutes les colonies obtenues après une année de contact avec l'eau de mer, la lysine décarboxylase, l'ornithine décarboxylase, la citrate déhydrolase ne sont plus actives. Après le premier repiquage sur gélose nutritive préparée à l'eau de mer (GNEM) ces cellules sont incapables d'assimiler les dix sucres étudiés sur des galeries Api 20E alors qu'après des repiquages successifs en bouillons et sur milieux solides elles deviennent actives et capables d'hydrolyser la gélatine. La dégradation du glucose par ces bactéries stressées ne se fait plus par la voie d'acides mixtes mais par la voie butanediole. Nous avons repris ce travail avec une autre souche de *S.wien* que nous avons incubée en eau de mer pendant quatre mois. Les mêmes modifications des caractères culturaux et morphologiques ont été observées. La capacité d'assimilation des sucres par les cellules incubées en eau de mer particulièrement l'arabinose et le glucose est modifiée : certaines de ces bactéries n'utilisent plus la voie d'acides mixtes au cours de la dégradation du glucose mais utilisent la voie butanediole.

S.wien non incubée préalablement en eau de mer donne des formes filtrables (ff) à travers les membranes à pores de 0,45 µm après 20 jours d'incubation en eau de mer. Le taux des (ff) reste faible par rapport au nombre total des bactéries. Ces formes semblent mieux survivre sur des géloses préparées à l'eau de mer. Les mêmes modifications des caractères biochimiques sont observées que dans le cas de cellules normales.

Variation du taux des formes filtrables de *S. wien* en fonction de la durée d'incubation en eau de mer et du milieu de récupération

Milieu de culture	GN		GNNaCl		GNEM	
Nombre de cellules/ml	N. total	N. (f f)	N. total	N. (f f)	N. total	N. (f f)
Durée d'incubation						
1 jour	10^5	0	$2\ 10^5$	0	10^5	0
20 jours	$2\ 10^5$	10	10^5	10	$4\ 10^5$	$2\ 10^3$
22 jours	$15\ 10^4$	10	45000	150	$8\ 10^5$	1500
24 jours	$2\ 10^5$	170	$2\ 10^4$	15	$14\ 10^4$	10^3
7 mois	10^3	2	10^3	7	17000	150

N:nombre ; N. (ff):nombre des cellules filtrables<0,45µm

L'étude de la résistance aux antibiotiques de *S wien* avant incubation en eau de mer et après quatre mois, sept mois et une année d'incubation dans cette eau a permis de voir que l'antibiogramme de cette souche reste le même et peut servir alors de marqueur épidémiologique.

Sur milieu solide (gélose nutritive), *S.wien* peut tolérer avant mise en contact avec l'eau de mer 35 g de NaCl/l, après une semaine d'incubation en eau de mer elle peut tolérer 45 g de NaCl/l.

De ces travaux, il s'avère que cette salmonelle peut bien s'adapter à l'eau de mer et peut présenter un danger pour les baigneurs et les consommateurs de fruits de mer dans les zones polluées par les eaux usées. Les modifications qu'elle subit touchent à des caractères impliqués dans l'identification du genre *Salmonella* ce qui lui permet d'échapper au dénombrement et aux recherches faits au cours de la surveillance sanitaire des eaux.

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Influence of inorganic Phosphorus on phosphatase activity in stationary phase culture of *Nannochloropsis gaditana*

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Some microalgae species are able to grow with glycerophosphate as the only source of phosphorus (LUBIAN, 1981), which implies the presence of phosphatases in the algae. This presence has been widely studied in both freshwater and marine microalgae (KUENZLER & PERRAS, 1965; LIEN & KNUTSEN, 1973; CARPENE & WYNNE, 1986). The phosphatase activity was also detected in *Nannochloropsis gaditana*, this microalgae show only a maximum at pH 5.5 for whole cell and soluble and particulate fraction (LUBIAN *et al.*, 1992). The regulatory role of phosphorus in the synthesis of acid and alkaline phosphatases was shown for several algal species (KNUTSEN, 1968; VAN BOEKEL & VELDHUIS, 1990). In this paper, we have studied the effect of inorganic phosphorus on phosphatase activity in stationary phase culture of *Nannochloropsis gaditana*.

Continuous culture of *Nannochloropsis gaditana* was carried out in a reactor of 1.5 l with f/2 medium enriched (GUILLARD & RYTHER, 1962), natural sea-water (36‰ salinity) containing a double amount of nitrate and phosphate at constant temperature of 20°C and continuous lighting (100 $\mu E.m^{-2}.s^{-1}$) with day light fluorescent lamps. When the phosphorus was omitted from medium the composition of this was the same but without phosphate.

Phosphatase activity was estimated by the liberation of p-nitrophenol from p-nitrophenyl ortophosphate (disodium salt, Merck) at saturating concentrations. Buffer was 100 mM citric acid/sodium citrate. When analyzing whole cell, buffer was made up with sea-water. For whole cell phosphatase activity, the reaction mixture contained 0.5 ml buffer, 0.5 ml microalgae culture and 50 µl substrate. Final concentration was 20 mM. For cell fractioning, the culture was centrifuged at 1600 g for 15 minutes, the supernatant discharged and the pellet washed twice in 0.6 M NaCl, 2 ml of 100 mM Tris-HCl at pH 7.0 were finally added and sonicated for 20 minutes in two steps. The extract was centrifuged for 15 minutes at 1600 g and the supernatant employed as enzyme source for the determination of phosphatase activity in soluble fraction. To the pellet resulting from the second centrifugation was added 2 ml of 100 mM Tris-HCl at pH 7.0 and sonicated for 5 minutes to resuspend it. The reaction mixture contained 1.0 ml buffer, 0.1 ml substrate and 0.1 ml extract or 0.1 ml of suspension depending on whether the soluble or the particulate fraction was analyzed. Final concentration was 50 mM. For all determinations of phosphatase activity a blank was run in parallel. The assay temperature was 30° C and incubation time was 60 minutes. The reaction was stopped by adding 100 mM NaOH to the reaction mixture. Phosphatase activities were calculated using a molar extinction coefficient of 18.5 cm^2. μmol^{-1} at 405 nm (WALTER & SCHUTT, 1974). Results are expressed as $U.(10^{12}cell)^{-1}$ ($1U=1\mu mol$ p-nitrophenol. min^{-1}). For determining of cell phosphorus, 15 ml of culture was centrifuged at 1600 g for 15 minutes, and the pellet resulting was washed with 0.6 M NaCl twice. The pellet was digested with potassium persulphate at 130°C for 60 minutes. Inorganic phosphorus was determined with an autoanalyzer Technicon TRAACS 800. The analytical method was a modification of GRASHOFF *et al.*, (1983).

Cell density showed a weakly increase in the period 0-72.5 hours (range 19.0-28.0 10^6 cell. ml^{-1})(Fig. 1A), thus inorganic phosphorus flux was eliminated at 25.5 hours. For this reason, a fast decrease was observed for it (15.6 µg-at $P.l^{-1}$ at 25.0 hours and 0.09 µg-at $P.l^{-1}$ at 195.5 hours)(Fig 1B). Thus at 193 hours an inorganic flux was newly added, inorganic phosphorus concentration only showed a little increase (2.5 µg-at $P.l^{-1}$). Notwithstanding cell phosphorus was increased at 1.8 µg-at $P.l^{-1}$ (Fig. 1A). Whole cell phosphatase activity (Fig. 1B) showed an increasing with time, ranging between 200 $U.(10^{12}$ cell$)^{-1}$ at initial period (0-72.5 hours) and 450 $U.(10^{12}$ cell$)^{-1}$ at last period (192-245 hours). A similar evolution for soluble fraction phosphatase activity was observed. In the case of particulate fraction a decrease was observed at final period.

Increase of whole cell phosphatase activity and the decrease of external inorganic phosphorus may reflect a dependence relation between them. The role of cell phosphorus in the regulation of phosphatase synthesis is likely important, however a gap period was observed in the response of phosphatase activity at the variation of cell phosphorus.

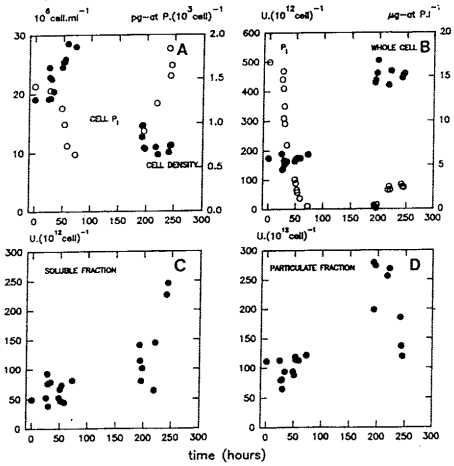

Fig. 1.- A) Cell density and cell phosphorus, B) Pi culture concentration and whole cell phosphatase activity C) and D) soluble and particulate fraction phosphatase activity, respectively.

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Relations entre le développement phytoplanctonique et le taux d'ammonification dans les sédiments de la Mer Ligure

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Dans les régions côtières, comme celles de la Côte d'Azur, les concentrations en sels azotés dans les sédiments marins superficiels varient au cours du temps. Fréquemment, les concentrations sont élevées au printemps et parfois aussi en automne (FERNEX *et al.*, 1989). Ces variations ont été mises en parallèle avec les apports de matière organique dans les sédiments superficiels (BOISSON M. *et al.*, 1988). Au cours de l'année, la matière organique est transportée vers les sédiments principalement par les pelotes fécales du zooplancton. Parmi ces organismes les salpes produisent le plus grand volume de pelotes fécales (NIVAL *et al.*, 1985). Le but de ce travail est de déterminer l'importance du flux de matière organique dû à l'action des salpes pour la production des sels nutritifs azotés dans les sédiments superficiels. Pour ce faire une formulation mathématique simple du fonctionnement du système est présentée et appliquée aux observations faites durant le premier semestre de 1988.

Matériel et méthodes

Le site étudié, la sortie de la rade de Villefranche sur Mer (prof. 80 m), est en zone côtière exempte d'influence fluviale directe. Les salpes (*Thalia democratica, Salpa fusiformis*) ont été collectées plusieurs fois par mois à l'aide d'un filet de 1mm de vide de maille tiré verticalement à partir d'une profondeur de 70m. Ainsi, 60m^3 d'eau ont chaque fois été filtrés. Les salpes ont été dénombrées à la loupe binocculaire. La biomasse phytoplanctonique est exprimée en µatg N en multipliant les teneurs en chlorophylle "a" (µg l^{-1}) mesurée par fluorescence (NEVEUX, 1976) par 0.65. Les sédiments ont été prélevés avec une benne Flucha à section carrée ne perturbant pratiquement pas le sédiments superficiel. Une épaisseur de deux centimètres du sédiment superficiel est prélevée et transvasée dans deux flacons de centrifugation. Immédiatement le premier flacon est centrifugé et l'eau surnageante filtrée à 0.2 µm après le retour au laboratoire. Le deuxième est mis en incubation dans l'obscurité à 13°C pendant 24 à 36 heures puis traité de la même façon que le premier. La différence des concentrations en sels azotés entre les deux flacons permet d'évaluer la production globale en sels nutritifs azotés du sédiment superficiel, qui est calculée en tenant compte de la teneur en eau; la production des sels nutritifs est exprimée en µatgN cm^{-3} s^{-1}. La même opération est effectuée sur les deux niveaux suivants (2-4 cm, 4-6 cm); la somme des trois valeurs permettra d'exprimer la productivité par unité de surface. Les sels nutritifs sont dosés suivant la technique de TREGUER et LE CORRE, (1975).

Résultats

Au premier semestre 1988, la biomasse phytoplanctonique augmente de mars jusqu'à mi-avril puis diminue jusqu'au début juin où elle se stabilise vers 0.15 ou 0.16 µg Chl "a" l^{-1}, soit environ 0.07 µatg N l^{-1}. A la mi-mars le nombre de salpes pêchées en un trait de filet est d'une dizaine, ce qui correspond à une concentration zooplanctonique (salpes s.l.) d'environ 0.3 10^{-3} µatg N l^{-1}. Cette concentration augmente rapidement pour atteindre 800 individus à la mi-mai, puis décroit pour devenir pratiquement nulle à la fin juillet.

On constate que le taux de production des sels nutritifs azotés dans les sédiments superficiels suit l'évolution du nombre de salpes.

Discussion et conclusion

Pour préciser les relations entre les concentrations en sels nutritifs azotés (N) dans l'eau de mer, la biomasse phytoplanctonique (P), la concentration de salpes (S), le taux de transformation de l'azote organique (particulaire) A) en sels nutritifs dans les sédiments superficiels, on utilise les formules ci-dessous adaptées de ANDERSEN *et al.* (1987). La première décrit les variations de concentrations du phytoplancton; la deuxième décrit la variation de la quantité de salpes. Les concentrations sont exprimées en µatg N l^{-1}, en estimant que le poids sec moyen d'une salpe = 0.5 mg, et que la biomasse de salpes dans un volume donné = le nombre de salpes dans ce volume multiplié par 2 µatgN.

$$(1)\ \frac{dP}{dt} = L\frac{N}{B+N}P - mP - I(1 - \exp(-K(P-Po))S$$

$$(2)\ \frac{dS}{dt} = aI(1 - \exp(-K(P-Po))S - (n+E)S \qquad (3)\ \frac{dA}{dt} = I(1-a)8\,10^4S - KA$$

avec: t= temps, L= coefficient dépendant de la luminosité et de la température, il est maximum en juin (Lmax= 0.63 j^{-1}); B= la moitié de la concentration optimale en sels azotés (B= 1.5 µatg N l^{-1}); Po= quantité minimum de phytoplancton au dessous de laquelle les salpes ne peuvent pas survivre (= 0.055 µatg N l^{-1}); m= coefficient de mortalité qui tient compte du rôle des autres herbivores, il est minimum au mois de mai (= 0.05 j^{-1}); I= maximum d'ingestion des salpes; k= coefficient d'ajustement; E= coefficient représentant l'excrétion par les salpes (0.1 j^{-1}; ANDERSEN *et al.*, 1987) n= mortalité des salpes (= 0.05 j^{-1} jusqu'au début juillet, 0.08 après).

Il faut noter que le terme L*N*P/(B+N) représente la production primaire, qui dans la région atteint son maximum entre la fin avril et la mi-juin (BROUARDEL et RINK, 1963; RODRIGUEZ-PRADA, 1973). Il s'agit de déterminer les valeurs des coefficients: a, I et K qui permettent d'ajuster les courbes des concentrations calculées aux valeurs mesurées. On trouve ainsi a= 0.14, I= 2 j^{-1} et K= 28.

Ainsi les salpes ingéreraient chaque jour une quantité de nourriture équivalente à 2 fois leur poids (sec) et rejetteraient 1.72 fois leur poids sous forme de pelotes fécales. Le taux maximum d'apport sur le fond qui a lieu en mai serait voisin de 2000 µatgN m^{-2} j^{-1}. Le maximum du taux de transformation de l'azote organique (ammonification) dans les sédiments a eu lieu, en 1988, en juin; il n'est que de 1000 µatgN m^{-2} j^{-1}, ce qui implique une augmentation des concentrations en azote organique particulaire dans les sédiments.

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M

Comparative survival studies of several bacteriophage groups in littoral seawater

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The amount of domestic sewage discharged into marine environment is increasing daily. These discharges produce physico-chemical and ecological disturbances, the importance and extent of which depend on several factors, such as: intensity and frequency of the discharges; dilution capability of the receiving marine ecosystem; and self-depurating processes in the sea. However, the most serious consequence derived from sewage discharges is related to the health-hazard associated with the recreational use of the contaminated-marine seawaters. There is considerable evidence suggesting the short-lived viability of most enteric pathogens outside the intestinal tract, except for the enteric viruses.

Several authors have suggested the use of bacteriophages as enteric viral pollution indicators, because of their similar behaviour and survival in the aquatic environment (SIMKOVA & CERVENKA, 1981; STETLER, 1984; BORREGO et al.,1990). However, the great variety of bacteriophage groups is an important shortcoming to the general use of the phages as viral indicators. Therefore, a comparative study on the survival capabilities of different bacteriophage groups is needed to establish their real validity as viral indicators.

Five bacteriophage groups (coliphages C, coliphages K12, F-specific coliphages, somatic *Salmonella* phages and phages active against *Bacteroides fragilis*) were comparatively studied on the basis of their survival and dispersion in littoral seawater. In all the cases, the double agar layer technique was performed for the phage assays, using as host bacteria the following: *Escherichia coli* C (ATCC 13706) for coliphages C; *E. coli* K12 Hfr (PC0008) for coliphages K12; *Salmonella typhimurium* WG49 for F-specific phages; *S. typhimurium* WG45 for somatic *Salmonella* phages and *B. fragilis* HSP40 for *Bacteroides* phages. Phage methodologies used in this study were those described by CORNAX *et al.* (1991).

Survival studies were conducted applying the techniques described by BORREGO *et al.* (1990) and CORNAX *et al.* (1991), and the time of residence or distance of dispersion were calculated according to the expression :

$$C=Co \times 10^{-x/x90}$$

X being the time or distance, and X90 the characteristic value of time or distance in which is achieved the 90% of disappearance.

Comparative survival characteristics of the different phage groups, measured both in time of residence and distance of dispersion in the seawater are given in Table 1.

All the bacteriophage groups showed higher survival capabilities than coliforms and generally a higher dispersion too. Inactivation rates of bacteriophages in the marine environment were similar to those of fecal streptococci. However, in laboratory conditions the bacteria are affected at high degree by seawater. This finding may be explained by the fact that in laboratory conditions the effects of adsorption, precipitation and sunlight are omitted, being these the main factors involved to the virucidal effects of seawater (BITTON, 1980; KAPUSCINSKI & MITCHELL, 1983). On the contrary, F-specilc phages possessed the lowest survival on laboratory conditions (5.7 h), which is in contradiction with the results obtained by several authors (AYRES, 1977; YATES *et al.*, 1985; HAVELAAR, 1987).

In conclusion, on the basis of the higher survival in marine environment, coliphages seem to be appropriate indicators of both, virus and bacterial pollution of this ecosystem.

Table 1. Comparative survival capabilities of different phage groups and indicator microorganisms in seawater.

	D90 (M)	T90 (h) Estuary	Open sea	Lab. Conditions
Total coliforms	215	0.73	0.26	3.7
Fecal coliforms	241	0.83	0.24	3.6
Fecal streptococci	346	0.69	0.34	8.0
Coliphages C	293	0.79	0.33	>15
Coliphages K12	284	NT	0.38	>15
F-specific phages	322	0.84	0.33	5.7
Salmonella somatic phages	206	0.70	NT	9.6
Bacteroides phages	170	0.67	NT	7.3

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Staphylococci in marine areas

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During the bathing, season 1991, Goletta VERDE for the Lega per l'Ambiente conducted the campaign for evaluation of sea water quality along the italian coastline.

The bacterial quality of the recreational water was assessed by the usual fecal indicators (total and fecal coliforms and fecal streptococci); as supplementary indicator, the occurrence of staphylococci was investigated.

The former microrganisms can indicate the presence of enteric pathogens. However, infections in bathing waters are not limited to enteric diseases but extend to the skin, ears, nose and throat (WHO,1986). Staphylococci are harboured in the mucous membranes, on the skin and hair follicles of warm-blooded animals. They can be washed out under all conditions of swimming so that their origin in bathing water is undoubtedly human activity. These microorganisms have been recommended as an index of bather pollution in swimming pool, as in lake and marine waters where low water exchange is present (FAVERO, 1985).

This investigation reports results obtained by analyzing 200 sea water samples collected along the Italian Coasts.

The area studied extends along the beaches of 10 Italian Regions.

As stated by the Italian legislation (DPR 470/82) on recreational bathing water total coliforms, fecal coliforms and fecal streptococci were enumerated. Moreover on the same samples the analyses for staphylococci were carried out.

All monitoring was done by membrane filtration (MF), total coliforms and fecal coliforms recovery was performed by using Endo and Teepol media, respectively. Fecal streptococci were enumerated on Azid medium and staphylococci on Vogel Johnson agar. For all the microrganisms 10 ml of seawater were filtered.

The data presented here indicate absence of correlation between the presence of fecal indicators and staphylococci. That can indicate that the usual bacterial species used as index of presence of enteric pathogens may, by themselves, not be adequate to ensure the bacterial safety of recreational waters in relation to water washed diseases. In fact, some beaches could be considered suitable for bathing when evaluated through the enumeration of fecal indicators. However, in the same seawater samples staphylococci occurred. It could be a suggestion for monitoring staphylococci as a supplementary indicator in overcrowded beaches because they will add valuable information on the sanitary quality of the seawater.

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M

La survie d'*Escherichia coli* en mer : le rôle possible de certains halophytes

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Introduction

L'utilisation de méthodes de comptage direct des cellules vivantes a permis de montrer que la mortalité des entérobactéries en mer n'est qu'apparente (COLWELL *et al.*, 1985; ROLLINS *et al.*, 1986). Mais pour pouvoir survivre dans un milieu a forte osmolarité, les cellules doivent d'abord retablir leur pression de turgescence par l'accumulation de potassium (EPSTEIN, 1986), et de glutamate, puis par la synthese et ou le transport de molecules organiques capables de rétablir la pression osmotique tout en diminuant la force ionique interne. Ces osmolytes peuvent être des sucres, (tréhalose), des acides amines (proline), ainsi que des composes amines quaternaires comme la glycine betaine. La présence de ces osmoprotecteurs dans le milieu environnant, dans la mesure où ils peuvent être transportés dans la cellule, peut donc favoriser la survie des entérobactéries en mer.

Les micro- et macro-algues marines, ainsi qu'une grande variété d'organismes marins, sont capables de synthétiser de très nombreuses molécules, et, par le biais de l'eutrophisation, fournir au sédiment de fortes quantités d'amines quaternaires et d'autres composés éventuellement capables d'améliorer la survie des entérobactéries. Ainsi, entre autres molécules, la glycine bétaïne a été retrouvée dans des sédiments marins (KING, 1988). Il était donc intéressant d'étudier le rôle que peuvent avoir certains halophytes marins (micro et macroalgues, phanérogamme) sur la survie d'*Escherichia coli* en eau de mer.

Résultats

La souche bactérienne utilisée était *Escherichia coli* MC4100 (CASABADAN 1976). Les souches d'halophytes ont été choisies parmi 9 genres de microalgues, une phanérogamme et une macroalgue. Les cellules bactériennes ont été cultivées à 37°C en présence d'extraits cellulaires aqueux d'halophytes, jusqu'à une densité optique de 0,2 (600 nm) puis rincées et suspendues en eau de mer stérilisée par microfiltration.

Dans ces conditions, la survie d'*Escherichia coli* a été fortement influencée par la présence des extraits d'halophytes: certains d'entre eux augmentaient la survie, alors que d'autres l'inhibaient plus ou moins fortement. D'autre part, certains extraits ont eu plutôt un effet à court terme (pendant les 2 premiers jours d'incubation en eau de mer, comme *Dunaliella bioculata*), alors que d'autres avaient plutôt un effet à long terme (6 jours, comme *Posidonia oceanica*) (Fig. 1).

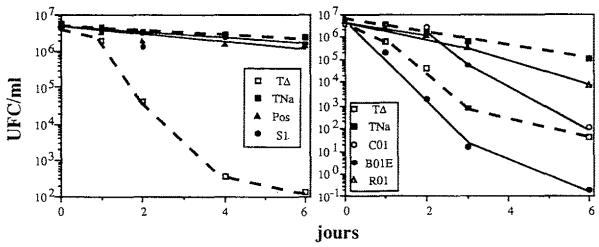

Fig. 1 : Survie en eau de mer des cellules d'*Escherichia coli* cultivées en milieu salé (0,5 M NaCl), (TNa), ou non salé sans ajout (TΔ), ou additionné d'extrait de *Posidonia oceanica* (Pos), *Bryopsis maxima* (S1), *Dunaliella bioculata* (CO1), *Asterionella glacialis* (B01E) ou *Porphyridium cruentum* (R01).

Une telle action sur la survie d'*Escherichia coli* pourrait être due au transport, à l'accumulation et éventuellement à l'utilisation de substances secrétées par les halophytes et qui pourraient réduire la survie comme dans le cas d'*Asterionella glacialis* ou au contraire la favoriser comme dans le cas de *Posidonia oceanica* ou de *Bryopsis maxima*. Une telle augmentation de la survie n'a pas pu être liée à la présence de composés possédant un ammonium quaternaire.

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Plant hormones - The probable link in the chain of processes leading to the phenomenon of "mucillagine" (Amorphous Aggregates)

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There are different inorganic and organic compounds in the sea water. Some of them, such as vitamins, enzymes, plant hormones, show the biological activity even if present at very low concentrations.

The presence of phytohormones in marine environment has heen confirmed by PEDERSEN (1973) and KENTZER (1980).

Growth regulators are mainly of physiological in origin as they are produced by some algae and bacteria.

According to MARUYAMA (1989) marine sediments and microorganisms living in them are the principal sources of plant hormones in the sea.

Agriculture and horticulture, in particular, also act as possible sources of these compounds since they are widely used, and may be transported by rainfall into the groundwater and thus by river to the sea.

The present work is an attempt, to explain the mechanism of mucillagine formation by means of a physiological study of marine algae.

Some of the plant hormones and their relationship with the mucopolysaccharides production was examined. We suggest that hormonal activity plays an important role as an ecological factor in the complex system of processes leading to the phenomenon of mucillagine.

Plant hormones, on one hand, derive from certain processes and, on the other hand, influence and regulate them, therefore in the following schema : **eutrophication... algal bloom... marine snow... filaments... mucillagine**, they may act, directly or indirectly.

Thus phytoplankton blooms, may cause an increase in plant hormone concentration in the sea water (as they are produced by algae) as well as having other ecological consequences.

At the same time the decay products of descending dead cells become a substrate for hormone production eg.some bacteria living in marine sediments are able to use tryptophane from algal cells as a precursor to the synthesis of auxin.

We studied the stimulating activity of plant hormones on the mucus production by the algal cells.

The preliminary results show that: the strongest effect is obtained with gibberellin GA3 at a concentration of 10 E-6 mg/dmc and with auxin IAA at a concentration of 1 mg/dmc.

Together with the increase in mucus content within the flocks of marine snow, there is also an increase in their stickiness which influences their potential for combining in larger aggregates.

These aggregates form filaments of so called mucillagine, whose biological activity may also play a certain role in this chain of processes.

As a result of our laboratory experiments on the biological activity of mucillagine, the increasing amount of mucus added to the diatom cultures caused a very significant increase in cell number, but didn't enhance the exudation of new mucus. However, it doesn't exclude the possibility of an indirect influence on the phenomenon of mucillagine since new cells appearing in great number may produce hormones.

The stimulation of algal mucus production by plant hormones together with other environmental factors result in a model which could explain the phenomenon of mucillagine formation.

However, care should be taken in drawing conclusions based on laboratory results about natural processes taking place in the marine environment because much greater number of environmental parameters should be considered (eg chemical, biological, physical, meteorological factors).

In addition one should remember the importance of cell sensibility which, of course, changes within their life cycle.

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M

Annual Pattern of heterotrophic bacteria and phytoplankton in a nitrogen rich coastal system

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The role of inorganic nitrogen in coastal environments has been studied extensively over the last decades (VALIELA, 1984). However, there is limited information concerning the ecological significance of organic nitrogen (FLYNN, 1990) and its role to the dynamics of the heterotrophic microbial flora (VAN WAMBEKE and BIANCHI, 1985) especially when eutrophic conditions are encountered. In the present work the annual pattern of nitrogen, phytoplankton, zooplankton and heterotrophic bacterial populations was studied in a near-shore environment affected by sewage pollution and the modelling of the bacterial subsystem was proposed.

Sampling was carried out bimonthly during 1991, along the coastal area of the city of Mytilini, Greece. Two stations M1 eutrophic and M2 oligotrophic were used to monitor inorganic nutrients and organic nitrogen (PARSONS *et al.*, 1989), phytoplankton, zooplankton and heterotrophic bacteria (APHA, 1985). Temperature, salinity, light extinction and dissolved oxygen were also recorded.

A summary of the data is given in Table 1. It is observed that station M1 showed values twice as high as the values in station M2. The load of heterotrophic bacteria and phytoplankton during the summer was found particularly high. A simulation model developed with special emphasis on organic matter and heterotrophic bacteria, was run on SENECA (1991) software. The seasonal variation of the variables involved is given in Figure 1. The inorganic nitrogen pool reaches a minimum during the summer whereas, phytoplankton and organic nitrogen showed maximum yield. Heterotrophic bacterial population showed an increase during August-October. The maximum bacterial activity was observed during the summer may be explained as the typical behaviour of nutrient non-limited system favoured by high temperature and light intensities.

Table 1 Minimum-maximum and mean values of five variables related to heterotrophic activity of bacterioplankton M1: Nitrogen rich station M2: Control site

Station	Nitrate ug-at/l	Org. N ug-at/l	Phytoplankton cells/l	Het. Bact. cells/ml	Zoopl. gr/m3
M1	0.14-4.94 0.82	6.5-25.8 17.82	17000-252000 82500	30-15525 2399	0.10-4.27 1.09
M2	0.01-0.37 0.17	0.4-27.4 14.32	10200-109000 48900	8-6563 1222	0.17-1.54 0.65

Further investigations are being carried out concerning microbial identification. succession and the use of validation data in further evaluation of the model and the understanding of heterotrophic microbial processes.

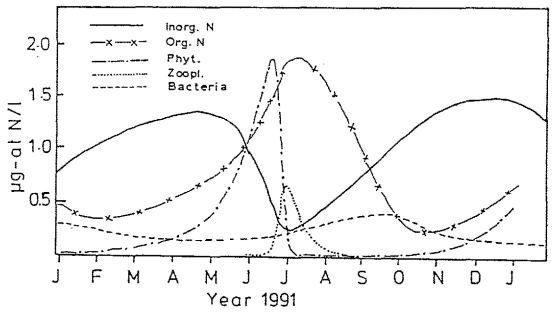

Figure 1. Annual fluctuations of five environmental variables related to heterotrophic microbial activities

Acknowledgement

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Vibrions isolés d'un centre d'Aquaculture de *Dicentrarchus labrax* en Tunisie

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Les vibrioses des poissons posent des obstacles sérieux dans les zones d'aquaculture des pays chauds. Dans ce travail, nous rapportons les résultats des enquêtes menées dans le centre d'aquaculture de Monastir (Tunisie) à la suite des épidémies à vibrions.

Les résultats obtenus représentés sur le tableau 1 montrent que *Vibrio parahaemolyticus* VPr et *alginolyticus* VAr peuvent être tenus comme responsables de ces épidemies car ils étaient isolés par hémoculture des géniteurs malades. Des souches présentant le même profil biochimique que VPr et VAr ont été trouvées dans l'eau et sur les parois des bassins d'élevage et peuvent présenter des formes endémiques.

Les souches isolées au cours des années 1991-1992 correspondent à *Vibrio alginolyticus* (profils 1,2,3 et 4).

L'étude approfondie des caractères de deux souches VPr et VAr identifiées respectivement à *V. parahaemolyticus* et *V. alginolyticus* isolées au cours des années 1989-1990 a montré qu'elles peuvent se multiplier en eau peptonée sans NaCI et peuvent tolérer des taux de NaCI allant jusqu'à 120 g/l d'eau peptonée. Elles ont la même résistance aux antibiotiques (tableau 2). Nous avons aussi déterminé la concentration minimale inhibitrice (CMI) de furazolidone pour les deux germes et nous avons pu voir qu'ils ont la même résistance: la CMI étant alors égale à 2,µg/ml. Ces vibrions ont pu survivre en flacons d'eau de mer pendant plus de vingt mois; leur résistance aux antibiotiques et aux métaux lourds n'a pas été modifiée.

Les souches isolées au cours de 1991-1992 se sont montrées moins résistantes aux antibiotiques. La résistance aux métaux lourds est plus forte dans le cas des souches isolées en milieu hospitalier (Tableau 3).

VPr et VAr non incubées préalablement en eau de mer évoluent vers des formes de taille réduite filtrables à travers la membrane à pores de 0,45 µm après trois semaines d'incubation en eau de mer seule ou additionnée à 50% d'eau de puits. Après un mois et demi d'incubation ces formes réduites ne sont plus détectables. Il peut s'agir d'une évolution vers des formes non cultivables telles que celles qui ont été trouvées chez *E.coli* (GAUTHIER *et al.* 1987). COLWELL *et al.* 1987 ont montré que les vibrions cholériques peuvent vivre en eau de mer à l'état libre sous des formes naines. Cette réduction de la taille des cellules peut être liée principalement à la carence alimentaire

Ces travaux montrent que *V. alginolyticus* et *V. parahaemolyticus* s'adaptent bien aux différentes conditions de la lagune et peuvent poser des problèmes d'épidémies graves pour les poissons particulièrement au cours des stades larvaires.

Tableau 1.- Caractères biochimiques sur des galeries Api 20E des vibrions isolés du Centre d'Aquaculture de Khniss.

Car / Souche	NO	TRP	GLU	ADH	URE	ESC	GEL	PNP	GLU	ARA	MNE	MAN	NAG	MAL	GN	CAP	ADI	MLT	CIT	F.G	OX
1989-1990																					
1:VPr	+	+	+	+	-	-	+	d	+	-	+	+	+	+	-	-	-	-	+	-	+
2:VAr	+	+	+	-	-	-	+	-	d	-	-	+	-	d	-	-	-	-	-	-	+
3:	+	+	+	-	-	-	+	-	+	-	-	+	-	-	-	-	-	+	-	-	+
4	+	+	+	-	-	-	+	-	d	-	-	+	-	-	-	-	-	+		-	+
1991-1992																					
1:	+	+	+	-	-	+	+	d	+	-	+	+	-	-	-	-	-	+	-	-	+
2:	+	+	+	-	-	+	+	d	+	+	+	-	+	+	+	+	-	+	+	-	+
3:	+	+	+	-	-	+	+	d	-	-	+	-	-	-	-	-	-	+	-	-	+
4	+	+	+	-	-	+	+	d	+	-	-	+	-	-	-	-	-	+	-	-	+

Tableau 2.- Résistance aux antibiotiques des deux vibrions étudiés.

Antibiotiques / Souche	*V. parahaemolyticus*	*V. alginolyticus*
Ampicilline	R	R
Ticarcilline	R	R
Amikacine	R	R
Gentamicine	R	R
Kanamycine	R	R
Tobramycine	R	R
Chloramphénicol	S	S
Tétracycline	R	R
Sulfamide	I	I

R : Résistant ; S : Sensible : I : Intermédiaire.

Tableau 3.- Résistance des vibrions aux métaux lourds.

CMI du métal en µg/ml / Souche	Hg	Cd	Zn
V. parahaemolyticus	25	150	50
V. alginolyticus	3,2	12	25
V. cholerae 01	50	350	100
V. cholerae NAG	50	250	70
V. cholerae INABA	50	250	70

Hg : mercure ; Zn : zinc ; Cd : cadmium.

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Quantitative study of *Vibrio parahaemolyticus* in sea water, shellfish and sediments of a marine area affected by a moderately polluted river discharge

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Vibrio parahaemolyticus is considered to be a part of the normal microflora of seawater and sediments of lukewarm seawaters (KANEKO & COLWELL, 1973). This microorganism is a potential pathogen of fish and shellfish and it has been involved in human illness caused by the consumption of raw or lighly cooked seafood (KATO *et al.*, 1970).

The distribution of *V. parahaemolyticus* in seawater, shellfish and sediments, in a marine area affected by the outfall of Guadalhorce river (Malaga, Spain), was studied.

The samples were collected from five sample stations, monthly during a year, and processed following standard procedures (APHA, 1985; FDA, 1978).

The most probable number of *V. parahaemolyticus* per 100 ml of water or 100 g of shellfish and sediments was studied by means of the multiple tube technique (APHA, 1985), using alkaline and saline peptone water, incubated at 36±1°C for 8 h and streaked on TCBS agar plates (DUPRAY & CORMIER, 1983). Presumptive*V. parahaemolyticus* colonies were confirmed according to the protocol described by FDA (1978).

The results, given in Figure 1, show that the annual evolution of the concentrations of the microorganism studied is almost parallel in the three types of samples. The mean concentrations ranged from <3 to 12 MPN/100 ml of seawater, from <3 to 208 MPN/100 g of shellfish and from<3 to 1280 MPN/100 g of sediments. These densities are very similar to those obtained by ABEYTA (1983), but lower than those reported by EL-SAHN *et al.* (1982). The level of accumulation in shellfish and sediments in relation with seawater is evident.

Two peaks of high density of microorganisms can be observed, one in May (15°C in seawater) another in October (18°C). In summer and winter *V. parahemolyticus* disappears, in coincidence with the highest and lowest water temperatures (22° and 13°C, respectively).

V. parahaemolyticus has never been detected in shellfish in enough number to be considered as a health hazard (10^6-10^7 per g), (TWEDT *et al.*, 1980), but it is demonstrated the high survival ability of this microorganism in shellfish, and its elevated resistance to the depuration (GREENBERG *et al.*, 1982; EYLES & DAVEY, 1984; MARTINEZ-MANZANARES *et al.*, 1991). For these reasons, the presence of this microorganism must be considered as a potential health-hazard associated with seafood consumption.

On the other hand, the role of marine sediments as a reservoir of *V. parahaemolyticus* has been demonstrated, and we consider that the follow up of this microorganism in sediments may provide an additional insight of the microbiological quality of shellfish growing areas.

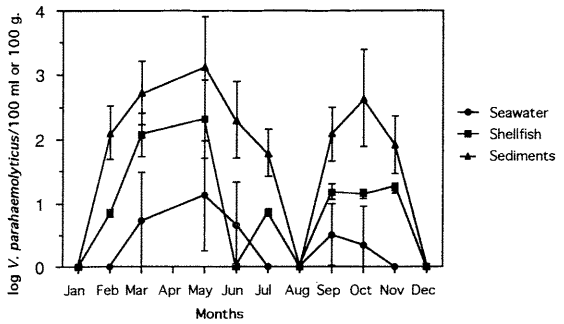

Fig. 1.- Temporal evolution of *V. parahaemolyticus* densities in seawater, shellfish and sediments

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Examen de la qualité de l'eau de mer par immunofluorescence

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Le degré de pollution des eaux de mer est évalué par le dénombrement et les indicateurs de contamination fécale que sont les bactéries entériques. Celles-ci donnent des informations sur leur présence dans les eaux usées. L'énumération des espèces indicatrices est effectuée au moyen de milieux de culture adéquats en suivant la technique conseillée par les Autorités Sanitaires.

L'utilisation des coliformes et des streptocoques fécaux comme espèces indicatrices est basée sur la connaissance de leur survie. Cette épreuve est réalisée sur les milieux de culture.

Récemment l'utilisation des méthodes culturales et des milieux sélectifs a été mise en discussion après que plusieurs auteurs aient découvert que les bactéries entériques, dans le domaine marin, ne perdent pas leur intégrité cellulaire pendant plusieurs jours, mais toutefois ne croissent plus dans les milieux artificiels. De plus ces bactéries ne perdent pas leur éventuelle virulence (GRIMES et COLWELL, 1986). La possibilité de démontrer au microscope à épifluorescence la présence de bactéries par les fluorochromes a fourni une méthode plus efficace pour la démonstration directe des cellules bactériennes. L'utilisation de l'orange d'acridine ou du DAPI a permis une évaluation plus exacte de la biomasse bactérienne dans les milieux marins. La non-spécificité de la méthode ne permet pas d'identifier les bactéries comptées mais il est possible d'utiliser un anti-sérum spécifique contenant les anticorps pour les différentes espèces recherchées.

Le dénombrement direct des cellules conduit à une inévitable révision des concepts de mortalité et des temps d'autodépuration dans la mer. L'utilisation de la méthode d'immunofluorescence (FA) pour la recherche spécifique des espèces indicatrices de contamination fécale et/ou des bactéries pathogènes (*Salmonella, Vibrio cholerae*), peut mettre en évidence toutes les bactéries qui ne sont pas à même de se développer sur les milieux culturaux Elles ne sont pas mortes mais elles sont transformées en cellules qui dorment et peuvent se réveiller quand, dans le milieu, il y aura des conditions plus favorables à leur multiplication.

XU *et al.* (1982) ont utilisé la technique du comptage direct au microscope à épifluorescence pour démontrer que *E. coli* et *V. cholerae* peuvent être viables même quand ils ne sont pas cultivables sur les milieux.

Dans des échantillons prélevés dans le Détroit de Messine au débouché du grand émissaire de la ville, on a utilisé les techniques culturales et celles du dénombrement direct pour la recherche de *E. coli* (ZACCONE *et al.*, 1991) et pour *Salmonella* sp. On a employé la méthode des membranes filtrantes pour les coliformes fécaux qui ont été concentrés sur un filtre de 0.2 µm de porosité. Pour la recherche de *Salmonella*, on a réalisé un enrichissement en bouillon de Sélénite (DIFCO) et Müller Kauffmann incubé à 37° C pendant 24h et l'épreuve de confirmation sur la gélose SS et "Hektoen enteric" (DIFCO).

Pour la méthode du comptage direct, on a suivi la technique de DESMONTS *et al.* (1990) modifiée, pour Salmonella et pour E. coli, celle de ZACCONE *et al.* (1991).

Le sérum antiSalmonella (polyvalent I, Behring) qui contient des immunoglobulines antiSalmonella (groupes A-E4) a été préliminairement testé avec les espèces suivantes: *Salmonella* (8 espèces), *Shigella* (2), *Citrobacter* sp, *Serratia marcescens*, *Hafnia alvei*, *Yersinia enterocolitica*, *E. coli* (3), *Pseudomonas* (3), *Proteus* (2), *Vibrio* (3), *Enterobacter agglomerans*, *Enterococcus* sp..

Dans l'eau de mer, on a toujours trouvé une charge plus élevée de *E. coli* (1-2 ordre de grandeur) et on a pu démontrer la présence de *Salmonella* plus rapidement et plus facilement avec la méthode de l'immunofluorescence (FA).

Les résultats posent le problème de la révision des techniques de numération conseillées par les Autorités Sanitaires. Ils encouragent à considérer l'opportunité d'évaluer les conditions dans lesquelles les cellules qui dorment retourneront à leur reprodution active dans le milieu ambiant et/ou dans les milieux de culture. Pour le *Vibrio cholerae*, on a vu que c'est surtout la présence du substrat qui joue un rôle très important dans la concentration et aussi dans la dissémination de cette bactérie qui vit et survit à la surface des copépodes (TAMPLIN et COLWELL, 1986). Pour *E. coli* aussi, il est démontré que certaines activités diminuent progressivement après la mise en eau de mer, dont la capacité de dégradation du lactose qui est fondée sur l'activité de la ß-galactosidase. Ces résultats nous poussent à modifier nos connaissances sur la validité du dénombrement bactérien dans les milieux de culture.

Il faut considérer la différence dans l'activité protectrice de la matière organique pour les bactéries libres et pour celles qui sont fixées aux matières en suspension où les bactéries peuvent trouver des microhabitats qui leur sont plus favorables.

La présence effective de germes pathogènes (comme *V. cholerae, Salmonella*, etc.) et des espèces indicatrices est aussi très importante pour le contrôle des eaux destinées à l'élevage de coquillages.

Dans le futur, on effectuera d'autres expériences de vitalité des bactéries au moyen de la méthode de KOGURE *et al.* (1979) ce qui permet de distinguer les cellules sensibles au traitement avec l'acide nalidixic et qui par conséquent sont considérées comme vivantes.

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M

Survival of skin pathogens in sea water

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Introduction

Staphylococcus aureus and *Candida albicans* are very widespread microorganisms which have been isolated from aquatic environments (BUCK & BUBUCIS, 1978; BORREGO *et al.*, 1987). The presence of these microorganisms in waters possesses a health hazard since they can infect ears, eyes, cuts, scratches on the skin of bathers.

In this paper, the effects of seawater on the survival of *S aureus* and *C. albicans* compared to the survival of two indicator microorganisms were studied under controlled diffusion chamber conditions.

Materials and Methods

The chambers used in this study were designed as described by FLIERMANS & GORDEN (1977), and before use they were autoclaved for 20 min at 121°C. UV-sterilized polycarbonate filters of 90 mm diameter and 0.2 m pore size (Nucleopore) were used as side walls for the chambers. The chambers were filled with filtered seawater, and transported to the experimentation area in containers filled with seawater. The strains employed in this study were: *Escherichia coli* (two strains isolated from seawater), *Enterococcus faecalis* (ATCC 19933 and one isolated from seawater), *S. aureus* (ATCC 29213 and one isolated from seawater) and *C. albicans* (CECT 1394). In the sampling area, a sterile syringe was used to inoculate 1 ml of the final cell suspension (c.a. 108 cfu/ml) of each strain into each chamber.

Enumeration of the samples was carried out following two procedures, the double agar-layer technique (ANDERSON *et al.*, 1983) used as control medium, and plating directly on selective agar plates. Tryptic Soy Agar (TSA) (Difco) was used as reference medium, and as bottom agar layer. The selective media used were: Endo Agar (Difco) for *E. coli*, KF Agàr (Merck) for *E. faecalis*, Mannitol Salt Agar (Difco) for *S. aureus* and mCA Agar (BUCK & BUBUCIS, 1978) for C. albicans. All samples were incubated at 37°C for 24 h. The percentages of both surviving and injured cells during time t were calculated by means of equations (1) and (2):

(1) % Survival = (Count on TSA at time t/Count on TSA at time 0) x 100

(2) % Injury = [l-(Count on selective media at time t/Count on TSA at time t)] x 100

Microbial inactivation was evaluated by applying the law of logarithmic decrease :

$C = Co x 10^{-t/T90}$ where, Co and C are the initial microbial concentration and the microbial concentration at t time, respectively, measured in hours. T90 is a constant characteristic of the process, that represents the time in which the initial population is reduced by 90 %.

Results and Discussion

In Table 1 it can be observed that the survival percentages for all the microorganisms tested were lower than 10 %. The highest percentages of injured cells at the end of the experiments (48 h of immersion) corresponded to *S. aureus* and *E. faecalis*, and T90 values of these microorganisms were also very similar. The survival of *C. albicans* was very similar to those of indicator microorganisms, and even at the end of the experiments the population of *C. albicans* showed a lower injury percentage than the other microorganisms. In contrast, the T90 value for *Candida* is the lowest. These data do not agree with those results which reported similar survival rates of *C. albicans* compared to indicator and other pathogenic microorganisms (CORNAX *et al.*, 1990). This result may be explained by a higher sensibility of this microorganism to the experimental manipulation before introduction into the diffusion chamber (CORNAX, 1986). This fact could provoke a rapid death of the injured cells, but this reduction of the population would not be due to the effect of seawater.

The lower injury percentages of *E. coli* and *C. albicans* in seawater may be due to the fact that they show different abilities to use the organic nutrients present in seawater. Similarly, SINCLAIR & ALEXANDER (1984) demonstrated that *E. faecalis* had a low capability to obtain energy from natural waters. However, several studies pointed out that the lack of nutrients in the water do not seem to be the main factor affecting the inactivation process of microorganisms in seawater (FUJIOKA *et al.*, 1981; DE VICENTE*et al.*, 1988; MORINIGO *et al.*, 1989; CORNAX *et al.*, 1990).

Table 1. Injury and survival rates and T90 values of the microorganisms in diffusion chambers experiments

Microorganisms	Injury percentage	Survival percentage	T90 value (hours)
E. coli	83.3 ± 4.6	8.0 ± 1.6	47.2
E. faecalis	94.0 ± 2.7	7.3 ± 3.6	37.0
S. aureus	96.2 ± 3.6	6.0 ± 2.9	34.0
C. albicans	79.4 ± 2.8	8.0 ± 3.3	24.0

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Mise en évidence de la nutrition bactérienne du Bryozoaire phylactolémate: *Plumatella fungosa* Pallas, 1768

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Les Bryozoaires forment un groupe important parmi la communauté des filtreurs, tant en milieu marin que dulcicole. Ils jouent par conséquent un rôle écologique non négligeable. Cependant leur nutrition est mal connue. Les quelques études qui y ont été consacrées montrent qu'ils se nourrissent de nanoplancton, d'algues et de diatomées (JEBRAM, 1980, KAMINSKI, 1984, WINSTON, 1976). Les auteurs s'accordent à dire que les bactéries sont également un des composants de leur nourriture mais jusqu'à présent aucune étude n'avait démontré ce fait. Des essais de nutrition bactérienne d'un bryozoaire marin ont été tentés par WINSTON (1976) mais sans succès.

Dans ce travail nous avons étudié la capacité des Bryozoaires à filtrer des bactéries et à s'en nourrir, en prenant comme modèle *Plumatella fungosa*, un bryozoaire d'eau douce. En effet, les bryozoaires d'eau douce présentent l'avantage de produire des formes de résistance, les statoblastes, qui peuvent être cultivés au laboratoire, permettant ainsi une expérimentation dans des conditions standardisées. Les statoblastes peuvent être conservés au froid pendant plusieurs années sans perdre leur pouvoir de germination.

Les statoblastes récoltés dans la nature ont été cultivés dans un milieu minéral mis au point pour la culture d'éponges (RASMONT, 1961). Après 3 jours, à 20°C et un éclairement de 12h par jour, les jeunes polypides deviennent visibles entre les deux valves du statoblaste. Cinq jours après l'éclosion, ils sont nourris avec des *Escherichia coli* colorés vitalement au formazan.

Cette technique nous a permis de suivre l'ingestion des bactéries, leur transit dans le tube digestif et leur émission sous forme de pelotes fécales colorées en rouge. Tous les polypides contiennent des pelotes fécales colorées dont le taux d'émission est fonction de la concentration bactérienne dans le milieu extérieur. L'observation microscopique des pelotes fécales montre qu'elles sont constituées de bactéries endommagées.

Des expériences ont été réalisées afin de quantifier le taux d'ingestion des *E. coli* en suivant leur disparition dans le milieu par dénombrement sur milieu sélectif (E.M.B. Difco). Cette quantification est toutefois difficile à réaliser étant donné que les pelotes fécales, émises à un rythme rapide, enrichissent le milieu.

Ces expériences montrent clairement que *Plumatella fungosa* est capable, non seulement d'ingérer des bactéries comme seule source de nourriture, mais aussi de les digérer. Il en est probablement de même pour les autres bryozoaires qui, de ce fait, joueraient un rôle considérable dans l'épuration des eaux.

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- Expérimentation en capteur à membrane -
Taux de survie d'*Escherichia coli* dans les eaux interstitielles de sédiments marins

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Les bactéries rejetées en mer s'adaptent plus ou moins aux conditions physico-chimiques du milieu marin. Rarement libres, elles suivent les mouvements de leurs supports qui peuvent flotter, floculer, entrer dans la chaîne alimentaire. La décroissance des bactéries est un phénomène mal identifié mais distinct d'une mortalité (BRISOU et DENIS, 1978).

Un consensus général se dégage pour reconnaître une disparition plus rapide des bactéries dans l'eau de mer que dans le sédiment .

Dans la littérature, la valeur du T90 (temps nécessaire pour que 90% des bactéries disparaissent), pour un germe donné reste très dispersée. Les raisons de cette disparité sont nombreuses. Elles tiennent d'une part à la résistance des bactéries à différents agents et d'autre part aux difficultés de mettre en évidence les possibilités de survie, de reproduction et d'expression de leur pouvoir pathogène.

Le lâcher de bactéries est impensable en milieu marin surtout dans le cas de bactéries pathogènes. C'est pourquoi le sac à dialyse est utilisé comme enceinte expérimentale. Ce matériel permet le maintien des principaux équilibres des phases dissoutes en permettant le passage des composés de faible poids moléculaire. Dans le sédiment, son utilisation est moins satisfaisante (colmatage, diffusion faible).

Nous avons donc testé un autre capteur à membrane ou "peeper" (HESSLEIN, 1976; BOISSON *et al.*, 1988)) comme enceinte pour l'expérimentation "*in situ*" de bactéries dans le sédiment. Ces expériences en écosystème contrôlé ont été effectuées dans des sédiments marins méditerranéens de zones plus ou moins polluées.

Ce capteur comporte, sur 30 cm de hauteur, 10 logettes superposées de 10 ml, recouvertes d'une membrane de 0,21lm de porosité. Le capteur est planté verticalement dans le sédiment.

Le principe de ce dispositif est basé sur l'équilibration d'eau distillée placée dans ses logettes, avec les eaux interstitielles du sédiment au travers d'une membrane. L'analyse de différents paramètres physico-chimiques, constituants et polluants est ainsi possible.

Dans les eaux des différentes logettes du "peeper", la matière organique dissoute (COD, bio-géopolymères) ainsi que les métaux sont évalués selon les méthodes précédemment décrites (BENAMOU *et al.*, 1990).

Les possibilités de survie *d'Escherichia coli* sont testées également. Nous avons utilisé pour cette étude les méthodes de dénombrement par culture, la mesure des activités enzymatiques (hydrolases) par la méthode semi-quantitative APIZYM, l'observation par épifluorescence après coloration à l'acridine orange (HOBBIE *et al.*, 1977) et la microscopie électronique à balayage (AFRIKIAN *et al.*, 1973).

Ce travail a permis de prouver l'utilité et l'efficacité du système pour l'étude "*in situ*" du devenir des bactéries dans le sédiment. La faible perturbation du sédiment par le "peeper", la possibilité d'échantillonnage "*in situ*", la fine résolution permettent une approche plus réelle des conditions spécifiques du milieu accepteur et de sa qualité.

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Données biochimiques sur les principales espèces d'Invertébrés du littoral Roumain de la mer Noire

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The most important quantitatively species *Mya arenaria, Mytilus galloprovincialis, Rapana thomasiana* and *Actinia aequina* on the Rumanian Black Sea coast are also the better investigated species. The paper emphasizes the biochemical differences versus age, species, population and ecological conditions; abiotic environment influences determinantly the global biochemical composition of the marine organisms.

Les espèces les plus importantes, du point de vue quantitatif, sur le littoral roumain de la mer Noire, et également les plus étudiées sont *Mya arenaria, Mytilus galloprovincialis, Rapana thomasiana, Crangon crangon, Palaemon adspersus* et *Actiia aequina* (ROSOIU, 1975, 1976, 1990; ROSOIU *et al* 1976, 1981). Le taux des composantes organiques présente 2 maxima1: au printemps et en automne (ROSOIU, 1975; STEPANYUK, 1967). L'accumulation des substances organiques au printemps s'explique par l'activation de tous les systèmes biochimiques en vue de se préparer du point de vue énergétique (lipides) et structurel (protéines) pour la reproduction; en automne, l'organisme accumule en vue de l'hivernage.

Les données du tableau mettent en évidence des différences selon l'âge, l'espèce, la population et les conditions écologiques, le milieu abiotique exerçant une influence déterminante sur la composition biochimique globale des organismes marins.

Composition biochimique globale moyenne des principales espèces d'Invertébrés du Littoral Roumain de la mer Noire

Espèce	Eau (% du tissu frais)	Eléments minéraux	% du tissu sec: Matière organique	Acides Protéines	Lipides	Glucides: Totaux	Glucides: Glycogène
Nereis diversicolor	87,60	15,20	84,70	8,75	54,70	14,30	15,80	13,30
Mya arenaria (1 ½ - 3 cm)	82,95	13,30	86,70	7,60	48,80	8,60	31,20	23,00
Mya arenaria (1 (4 - 5 cm)	82,60	10,65	89,35	7,25	45,30	8,40	35,60	21,10
Mya arenaria (1) (7 - 8 cm)	81,65	11,50	88,50	6,95	44,80	8,60	35,10	16,50
Scapharca inaequivalvis	90,90	9,90	90,10	8,90	55,60	8,20	26,50	-
Ostrea edulis	82,40	4,15	95,85	7,30	45,70	7,00	43,20	28,50
Mytilus galloprovincialis	76,90	4,30	95,70	9,95	62,20	15,70	17,90	10,60
Mytilus galloprovincialis	82,30	8,90	91,10	9,50	59,25	8,90	22,90	-
Mytilus galloprovincialis	83,20	12,40	87,60	7,45	46,60	9,10	32,00	-
Mytilus galloprovincialis	83,30	10,50	89,50	9,30	58,20	9,60	21,60	-
Mytilus galloprovincialis	83,20	7,50	92,50	9,70	60,60	9,40	22,50	-
Mytilus galloprovincialis (moule de rocher) (1-3 cm)	83,00	8,70	91,30	8,90	55,70	8,40	27,05	18,10
Mytilus galloprovincialis (moule de rocher) (4-5 cm)	83,60	9,80	90,20	9,10	56,90	11,70	27,60	-
Mytilus galloprovincialis (moule de rocher) (7-8 cm)	86,00	10,00	90,00	9,00	51,80	12,10	25,70	20,50
Mytilus galloprovincialis (moule de profondeur) (1-3 cm)	79,50	8,40	91,60	8,00	51,50	9,00	32,80	-
Mytilus galloprovincialis (moule de profondeur) (4-5 cm)	80,55	8,30	92,10	7,70	48,30	11,40	32,30	-
Mytilus galloprovincialis (moule de profondeur) (7-8 cm)	81,30	10,00	90,00	6,60	38,90	11,00	43,30	-
Rapana thomasiana	71,15	7,45	92,55	8,70	54,60	4,20	28,30	-
Nassarius reticulatus	70,80	10,20	89,80	7,90	49,50	7,90	32,20	-
Pontocinnamus mesolicus	81,70	20,30	79,60	7,05	44,10	16,70	17,90	-
Idotea baltica	75,80	27,30	72,70	7,90	49,10	9,90	13,65	12,20
Carcinus mediterraneus	88,70	13,35	66,65	10,30	54,60	7,60	14,50	6,40
Crangon crangon (ovigère)	77,70	16,70	83,30	8,40	52,60	4,10	26,60	-
Crangon crangon (nouvigère)	79,00	14,10	85,90	9,10	57,10	6,20	22,65	-
Palaemon adspersus (ovigère)	75,55	11,80	88,20	9,70	60,80	7,25	19,60	-
Palaemon adspersus (nouvigère)	76,70	15,20	84,80	7,90	49,20	4,50	30,90	-
Actiiella adspersus	96,80	16,85	83,15	5,50	34,40	4,40	44,40	34,20
Actinia aequina	84,45	8,60	91,40	8,70	54,60	15,80	28,00	-

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M

Données biochimiques sur les principales espèces de Poissons qui peuplent le Littoral Roumains de la Mer Noire

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Summary

Alosa tanaica nordmanni, Engraulis encrassicolus poncticus, Odontogadus merlangus euxinus and *Trachurus mediterraneus poncticus* are the investigated species. The marine organisms, presently the fishes, interact with biotic and abiotic environmental factors : water containing dissolved minerals, food and other organisms. The homologous tissues in the fishes belonging to different species present a different biochemical content.

Comme tout organisme marin, les poissons interagissent avec les facteurs du milieu, abiotiques et biotiques : l'eau avec les sels des poissons appartenant à différentes espèces ont une teneur biochimique différente. La plus grande quantité de microéléments dans les muscles est trouvée dans les poissons planctonophages (*Alosa tanaica nordmanni, Engraulis encrassicolus poncticus, Sprattus sprattus sprattus*). Su l'on compare la structure biochimique des poissons planctonophages avec leur source de nourriture, le zooplancton, on constate que ce dernier concentre un taux plus élevé de microéléments que les poissons, servant donc de source d'éléments chimiques pour les poissons (SULIMAN, 1971). Les espèces de poissons que nous avons étudiées contenaient de grandes quantités de Na, K, Ca, Mg, Cu, Zn et Fe tandis que le Pb, le Cd et le Cr étaient absents.

Les nombreuses recherches sur les organismes marins et, implicitement sur les poissons, concernant la dynamique mensuelle des compsants organiques, ont prouvé la richesse de ces organismes en protéines, lipides et glucides au printemps et en automne. L'accumulation des composants organiques au printemps s'explique par la mobilisation des réserves énergétiques et constitutif en vue de la reproduction, et en automne par la préparation de ces organismes envue de l'hiver (ROSOIU, 1975; STEPANYUK, 1967). Les données concernant la teneur biochimique globale et en acides aminés sont présentées dans le tableau. Chez les poissons, le glycogène est localisé surtout dans le foie, les muscles, le coeur et le cerveau. Les poissons actifs ont les réserves fondamentales de glycogène dans les muscles. Les variations mensuelles les plus évidentes du taux de glycogène sont enregistrées dans le foie et dans les muscles. Chez les poissons, le foie est une véritable réserve de glycogène, qui est intensément consommé pendant le jeûne de l'hivernage prolongé. En hiver, le glycogène des muscles est utilisé surtout comme un support énergétique en vue du mouvement; c'est pourquoi ces variations quantitatives sont moins liées aux rythmes saisonniers. Lors des efforts de longue durée, on mobilise, à côté des lipides, les réserves de glycogène du foie.

Composition biochimique globale et teneur en acides aminés des principales espèces de poissons du littoral roumain de la Mer Noire (% tissu sec)

	Espèces			
	Alosa tanaica nordmanni	*Odontogadus merlangus euxinus*	*Engraulis encrassicolus poncticus*	*Trachurus mediterraneus poncticus*
Acides aminés				
cystine + cystéine	0,85	2,70	2,05	2,00
lysine	3,20	2,40	2,50	2,45
histidine	11,95	3,20	10,00	9,00
acide aspartique + sérine	9,65	5,20	5,50	6,70
glycocolle	3,15	2,40	3,90	2,10
acide glutamique	5,45	6,40	9,65	8,70
alanine	3,65	4,35	7,05	6,55
proline	2,65	2,65	1,30	2,20
acide + aminobutyrique	8,20	5,25	1,40	2,15
tyrosine	2,55	2,70	1,20	2,90
méthionine	2,50	4,24	5,60	4,35
phénylalanine	10,50	8,40	4,95	8,60
leucine	2,45	5,00	6,45	5,35
Total	66,75	54,90	61,55	63,05
Eléments minéraux	17,00	21,00	11,00	10,62
Azote total	12,50	9,00	12,00	9,20
Protéines	66,00	55,00	65,00	58,70
Lipides	8,50	7,00	13,50	22,25
Glucides : - totaux	17,00	14,80	13,20	11,10
- glycogène	13,25	11,80	10,10	9,85

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Contribution à la connaissance du rôle spécifique des composantes biochimiques du milieu marin - eau et sédiments - dans le déroulement des processus de transformation des substances complexes

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This paper presents some preliminary results refering to metabolits from the sea water and sediments: glucides, proteins, aminoacids, lipids, nucleic acids, with the purpose of emphasizing the spatiotemporal variations of the physical, biochemical, biological parameters which are influenced by anthropic factors.

Nous avons procédé au prélèvement d'échantillons d'eau de 9 stations et de sédiments d'une autre série de 10 stations, sur le littoral roumain de la mer Noire. Ont été déterminés les éléments minéraux, les glucides, les protéines, les acides aminés, les lipides et les acides nucléiques.

Dans les échantillons de sédiments prélevés à des profondeurs allant de 32 à 130 m, la teneur en acides aminés varie de 0,40 g% de poids sec à 1,90 g% de poids sec avec une prédominance des acides aminés soufrés.

Dans les échantillons des stations 14 et 15, on a décelé un surprenant taux d'oxyproline, acide aminé absent dans les autres échantillons, ce qui indique d'intenses réactions d'oxydoréduction dans les sédiments situés devant la ville de Constantza. Les taux les plus élevés de protéines totales dans les sédiments se retrouvent aux stations du profil Est-Constantza. Il n'y a pas de variations importantes dans le taux des protéines totales et des protéines solubles selon la profondeur de prélèvement des échantillons.

Les glucides et leurs dérivés sont très répandus dans l'eau de mer, dans les matières en suspension et dans les sédiments. La teneur élevée en glucides, relevée à la surface et aux profondeurs de 30 et 40 m indique qu'un "métabolisme" plus intense se développe devant la station Sfintu Gheorghe, ce qui s'expliquerait par l'apport de substances organiques des eaux du Danube se déversant en mer. Sur le profil Est Constantza on observe également un taux élevé de glucides, généré par des processus métaboliques intenses. Dans les sédiments, le taux de glucides est plus petit par rapport aux protéines totales, sans qu'il n'y ait une corrélation quelconque dans leur variabilité.

Les lipides naturels de l'eau marine, de la matière en suspension et des sédiments, représentent un mélange hétérogène de composantes dans lequel entrent les lipides complexes des organismes marins et également leurs dérivés, combinaisons formées à la suite de la transformation de la substance organique vivante. Une part des lipides, surtout les hydrocarbures, pénètre en mer à la suite d'activités humaines. Dans les échantillons d'eau prélevés, et surtout dans ceux de surface, la teneur en lipides est extrêmement grande, ayant généralement un ordre de grandeur de 10^6 supérieur à celui des glucides; cela s'explique par la pollution pétrolière de la mer Noire qui modifie la composition des lipides dans tous les organismes marins.

Le grand taux d'acides nucléiques (ADN + ARN) déterminé en mer, dans tous les échantillons analysés, reflète un fort métabolisme énergétique et la présence de la substance organique tant endogène qu'exogène.

M

Dynamics of bacterial-phytoplanktonic systems influenced by eutrophication

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The fluctuations of heterotrophic bacterial number depends on the availability of organic matter resulting from sewage effluents and planktonic excretions (1). The study of such relationships in the marine ecosystem is complicated and therefore the use of microcosm systems can be useful in understanding heterotrophic processes. In the present work, the interactions between phytoplankton, heterotrophic bacteria and dissolved organic matter (DOM) was studied in the laboratory.

The marine alga *Dunaliella tertiolecta* was used for the experiments. Methodological details have been given in a previous work (2). The cultures were enriched during the exponential phase with sewage effluent after filtration and sterilization. Phytoplankton cell number, heterotrophic bacterial cell number, COD and organic nitrogen were measured every three days for two weeks.

Table 1: Phytoplankton-bacterial division rate (r) and carrying capacity (k) (cultures in 2 replicates)

Treatment	r (divisions/day)		k (cells/ml x 10^5)	
	Phyt.	Het.bact.	Phyt.	Het.bact.
Control culture	1.2 ± 0.4 1.1 ± 0.6	1.1 ± 0.5 0.9 ± 0.8	36 ± 2 37 ± 3	600 ± 70 560 ± 30
Add. of sew.eff.	1.2 ± 0.4 1.2 ± 0.5	2.1 ± 0.7 1.3 ± 0.7	42 ± 8 41 ± 7	870 ± 80 480 ± 30

FIGURE 1

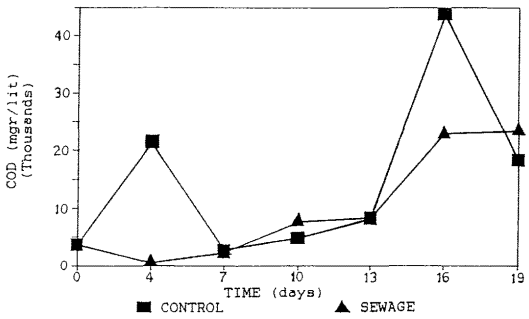
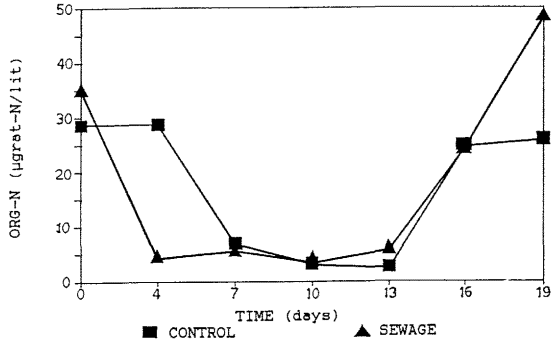


FIGURE 2



It was observed that division rates in heterotrophic bacteria were higher in the presence of sewage effluent (Table 1). The algal carrying capacity was also found increased in the presence of the effluent. COD showed an increase after the 13th day of growth (Fig. 1). The trend observed in organic nitrogen was different (Fig. 2); the available organic nitrogen was decreasing during the first week probably due to the bacterial uptake. The logarithms of heterotrophic bacterial number and organic nitrogen were highly correlated until the 13th day of the culture, with a negative correlation coefficient of 0. 77 for the control and 0. 90 for the other treatment. The low organic nitrogen levels (7th-13th day) were followed by an increase which may be associated with the senescence of the algal culture. The logarithms of phytoplankton and heterotrophic bacterial cell numbers were highly correlated with a linear relation. The correlation coefficient was found 0. 96 for the control and 0. 98 for the other treatment.

The dynamics between organic nitrogen and phytoplankton-bacterial growth is being investigated using mathematical modelling.

Acknowledgement

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Chlorophyll distribution throughout the Levantine Basin

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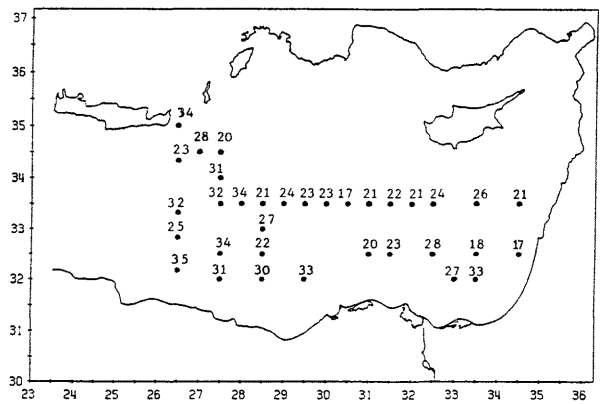
The vertical distribution of chlorophyll a in the upper 200 m of the water column was recorded throughout the Levantine Basin of the Eastern Mediterranean (Fig. 1), as part of the autumn 1991 POEM Multinational Program. Chlorophyll a concentration (determined fluorometrically on duplicate extracts in the upper 200 m ranged from 9.2 to 423 ng l^{-1}, with an overall mean of 126 ± 85. 6 (SD) ng l^{-1}. In 5 stations chlorophylls were determined on water samples from 300 m. The concentrations ranged from 3.3 to 18.8 ng l^{-1}. These concentrations fall within previously reported (AZOV, 1986; BERMAN *et al.*, 1986; KIMOR *et al.*, 1987; SALIHOGLU *et al.*, 1990) ranges for the pelagic water of the Eastern Mediterranean. The vertical distribution of chlorophyll was close to uniform throughout the basin, with a prominent deep chlorophyll maximum (DCM) of about 250 ng l^{-1} at 90-110 m, corresponding with the depth to which about 1% of the incident light penetrated. Exceptions were two stations, located approximately within the Marsa Matruh Gyre, in which a more even depth-distribution of chlorophyll was observed, with >100 ng l^{-1} extending down to 200 m depth and no distinct DCM. Integrated water column (0-200 m) chlorophyll content ranged between 17-35 µg m^{-2}, with higher values close to the African coast and in the western part of the Basin (Fig. 1). This pattern corresponded with Secchi transparencies that were generally shallower at the sites with higher chlorophyll content.

Water samples from 0, 50 and 100 m at the stations along latitude 33.30 N were fractionated on 2 µ and 10 µ polycellulose filters. More than 90% of the chlorophyll was confined to particles <10 µ and more than 50% was found in particles <2 µ. The proportion of chlorophyll in <2 µ particles increased with depth and exceeded 70% at 100 m depth. The pattern was similar at the different stations. Furthermore, in the upper 90 m of the water column acidified chlorophyll extract comprised about 60% of the native extracts, while at deeper depths this proportion gradually increased. This implies that pigments other than chlorophyll a, which contribute to the fluorescence of the acidified extract, became more abundant at the deeper depths. Such a pigment is chlorophyll b, which was found by HPLC analyses to be abundant in Eastern Meditteranean samples from DCM layers in September 1989 and October 1990 (YACOBI, unpublished data). The increase with depth in the contribution of small particles to chlorophyll concentrations, and the concomitant increasing proportion of acidified extract suggest that the chlorophyll b containing prochlorophytes dominate the DCM of the Levantine Basin, a hypothesis that needs confirmation.

Fig. 1. Station positions (circles) for IOLR POEM cruise (14 Oct-10 Nov 1991), and the distribution of depth-integrated (0-200 m) chlorophyll a concentration (µg m^{-2}; values above circles).



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M

Bacterial abundance and production throughout the Levantine Basin

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The spatial distribution of bacterial abundance and production were recorded for the first time throughout the Levantine Basin of the Eastern Mediterranean, as part of the autumn 1991 POEM multinational program. Detailed depth profiles were conducted at 10 stations on an East-West transect along latitude 33° 30' N, and at 5 stations along a NW-SE transect from 35°N, 26° 30'E (near Crete) to 33°N, 28° 30' E.

Bacterial numbers in the upper 200 m ranged between 4×10^4 and 4×10^5 cells ml^{-1}, with an overall mean of 2×10^5 cells ml^{-1}. Bacterial numbers were generally highest at the surface, declined with depth, and were higher along the E-W transect than along the NW-SE transect (Fig. 1). Bacterial volume, determined by image analysis of cells from the upper 100 m, averaged 0.045 $\mu m^3 \pm 0.010$ μm^3 SD for 512 cocci, and 0.106 $\mu m^3 \pm 0.069$ μm^3 SD for rods, spiral and comma-shaped cells.

Bacterial production, measured as the rate of incorporation of ^{3}H-methyl thymidine (TdR) into DNA, ranged from below detection level (<0.02) to 1.28 pmol l^{-1} h^{-1}, with a single unusually high value of 3.9 pmol TdR l^{-1} h^{-1} at 100 m depth. This occurred at the same station (within the Marsa Matrun Gyre) and 10 m above the site of the highest chlorophyll recorded for the basin. The overall mean incorporation rate of the 159 duplicate samples analysed was 0.31 ± 0.38 (SD) pmol l^{-1} h^{-1}. The rates exhibited greater vertical patchiness than bacterial cell numbers or chlorophyll concentrations. We have confidence in our measured values because of ± 10% agreement between duplicate measurements. Peaks in bacterial activity were often, but not always, associated with the deep chlorophyll maximum (DCM). Along the E-W transect bacterial production maxima at 200 m (the deepest depth examined) were found in 6 stations, while surface maxima were found in two. The stations along the NW-SE transect showed additional peaks of bacterial production above or below the DCM, but not at the surface or at 200 m. Unexpectedly high rates were recorded at one out of three stations in which bacterial production was measured also in deep water (0.57 and 0.74 pmol l^{-1} h^{-1} at 500 and 1000 m, respectively).

Generation times, calculated assuming 1 mole of thymidine incorporated = 1018 cells, averaged 50 days (range: 0.9-1050 days) and tended to be longer beneath the DCM. The long generation times, together with the low bacterial numbers and thymidine incorporation rates (both of which fall at the lower end of previously published ranges for oligotrophic seas) are in accordance with the ultra-oligotrophic nature of the Levantine Basin.

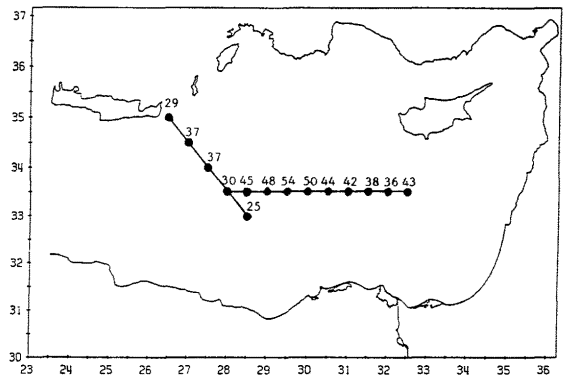

Fig. 1. Station locations (circles) along transects and the distribution of depth-integrated (0-200 m) bacterial numbers (1012 cells m-2) in the Levantine Basin, Eastern Mediterranean Sea.

M

Seasonal and Mesoscale variabilities of the Northern Current from the PRIMO-0 observations in the Ligurian Sea

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Institut de Ciències del Mar, BARCELONA **(Spain)

The PRIMO-0 experiment was carried out in the Corsican Channel, the Ligurian Sea and the Channel of Ibiza during about six months, from December 1990 till May 1991 in order to investigate the seasonal variability of the general circulation in the northern part of the western Mediterranean Sea. In the Ligurian Sea, 6 moorings (out of 9) supporting about 30 current meters (at ≈ 60, 100, 150, 250, 500, 1000, 1500 and 2000 m) were set in place as far as 30 nautical miles off Nice and were completed with a fortnightly hydrological survey at 13 equally-spaced stations; here we mainly deal with the current measurements. The observations were made simultaneously in the coastal area under the influence of the Northern Current and in the offshore area where deep water formation processes occur in winter, so as to emphasize likely relationships between these advective and convective phenomena (ASTRALDI and GASPARINI, 1990; MADEC *et al.*, 1991).

The most interesting result is that the monthly mean currents, computed at each mooring over the 250 upper meters, show that the Northern Current flows nearer to the coast and intensifies in February until mid March when it reaches its maximum. These features are different from what has been previously shown in the Corsican Channel where the Eastern Corsican Current is maximum in January (ASTRALDI and GASPARINI, 1990). Nevertheless, the intensification of the Northern Current at nearly the end of the deep water formation season migth support the link above-mentioned between these two phenomena.

The seasonal variability is well defined in both areas as previously observed (TAUPIER-LETAGE and MILLOT, 1986), it is characterized by an intense mesoscale activity in winter, especially from late December to February. In the coastal area, the mesoscale events are coherent over the whole width of the Northern Current. They are baroclinic and can reach depths of about 1000 m: they are associated with relatively large temperature fluctuations. On the outer edge of the current, these events become deeper and deeper from February until getting a barotropic structure in March over the whole 2000 m depth, while the monthly mean current becomes minimum: at this time the structure is characteristic of the offshore area.

A fine resolution on the vertical has revealed that current values down to 150 m in the Northern Current are similar: this upper part of the current reacts as a sole layer during the studied period. The mesoscale events, especially the more intense ones, have a characteristic signature on both current and temperature leading us to emphasize some aspects of their structure, these perturbations could be induced by instabilities of the Northern Current. From February to mid March these events weaken more or less everywhere while homogeneous low temperatures settle over both areas down to 150-200 m. At the end of March, the intensity of the mesoscale events is reduced and the stratification appears again. Since early May the mean current becomes relatively steady and it will remain like this till autumn (SAMMARI *et al.*. 1992).

Another interesting observation is that the current values close to the bottom, especially at the foot of the continental slope, are relatively large; for instance, the mean and 6-hour maximum values are ≈3 and 18 cm/s at ≈2000 m and ≈1 and 7 cm/s at ≈1000 m. This is coherent with observations made off Algeria (MILLOT *et al.*, 1992) and can be induced by interactions between the current and the topography.

So. the intensification of the Northern Current, its shorewards shift and the weakening of the mesoscale events in mid March, at the end of the deep water formation season, might bring enlightenments on the relationships between the general circulation and the convective phenomena.

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The Mediterranean Conveyor Belt

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(***) IMGA-CNR, MODENA **(Italy)**

Abstract

Multi-decadal integrations of the Pacanowsky, Dixon and Rosati version of the Bryan and Cox general circulation model have been carried out in order to study the characteristics of the Mediterranean conveyor belt. The model is forced at the air-sea interface by monthly mean atmospheric winds, air temperature and relative humidity to calculate bulk parameterized momentum and heat fluxes. Water fluxes are parameterized by a Newtonian relaxation term to monthly mean climatological surface salinities and the Gibraltar inflow condition is forced by an annual mean temperature and salinity structure.

The resulting overturning component of the thermohaline circulation can now be connected to the rather complex forcings of the general circulation, such as the air-sea interactions, the Gibraltar inflow/outflow system and the deep water sinking at northern latitudes (Gulf of Lyon and Adriatic Sea). We analyze the meridionally and zonally integrated mass transports in the western and eastern basins to examine the character of the overturning cell and its connection with the forcing at Gibraltar. Sensitivity experiments to different surface forcing parameters will be also shown.

O

The influence of the N.W Aegean Sea waters on the Physical characteristics of the Pagassitikos Gulf

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Abstract

Recent hydrological investigations in the Aegean and Ionian Sea reveal that the waters of the NW Aegean Sea, are strongly affected by the inflow through the Dardanelles of Black Sea - Marmara Sea waters (THEOCHARIS *et al.*, 1992). This is more evident in the NE Aegean Sea (surface salinity values: 33.5-34.4), but the Western North Aegean Sea is also influenced (Surface salinities: (33.5-37.7). Consequently, the lower surface salinities covering all over the Pagassitikos Gulf. lead to the conclusion that the source water of the Gulf must be the NW Aegean Sea waters and not the fresh water outflow from the surrounding area of the Bay of Volos (Fig.1). Figure 2, summarizes the three years (1986-1989) seasonal salinity surface (0-20m) layer variations as compared to the integrated mean salinity values of the entire water column. It demonstrates that salinity minima are achieved in late summer to early autumn.These salinity variations dislay similar trends with the equivalent salinity variations in the NW Aegean Sea, providing further evidence that the renewal of the Pagassitikos Gulf surface waters is mainly affected by the inflow into the Gulf of the NW Aegean Sea waters. Furthermore, the analysis of the current meter data reveals that the renual of the water in the Gulf, in the near - bed layer, is made by the intrusion of the Aegean Sea water along the eastern coastline of the Gulf entrance, and outflow of the water along the western section. In the upper layer, the water circulation is in the opposite direction (BALOPOULOS *et al.*, 1987).

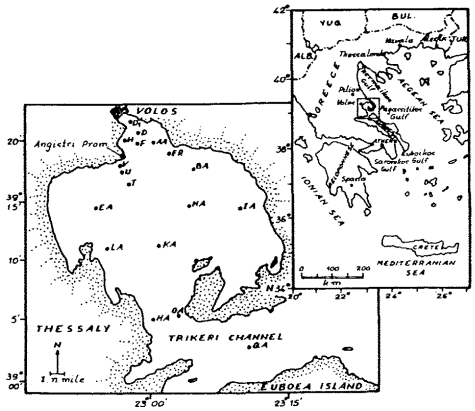

Fig.1: Sampling locations in the Gulf of Pagassitikos.

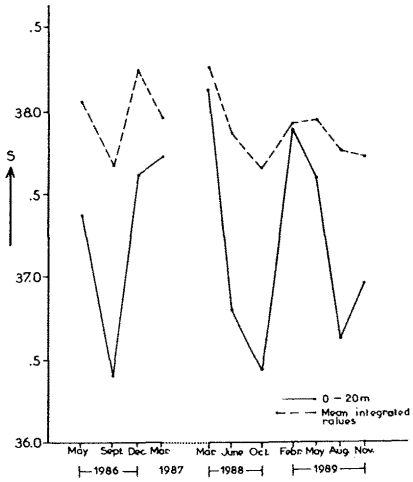

Fig. 2.- Salinity variations in station IA of the surface layer and corresponding integrated mean values (1986-1989)

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The Simulation of the Month to Month Variability of the Western Mediterranean Circulation

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(1) Research Assistant, National Fund of Scientific Research.

Using the GHER 3D non linear primitive equation model (e.g. BECKERS, 1991), the month to month variability of the general circulation in the Western Mediterranean Sea is established. It will be shown that the main physical features are well represented (the deep water formation is shown as an example on figure 1), but that the choice of initial conditions is crucial as well as the boundary conditions.

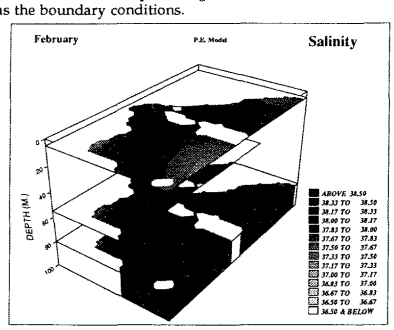

Fig. 1.- 3D view of the deep water formation in the Gulf of Lions. Salinity field in February.

In a first simulation, Levitus climatological data set was forced by the monthly mean May atmospheric data. The results showed herafter were obtained after 3 years of simulation. With these initial conditions and forcings, only a weak month to month variability was detected.

For a second simulation, the BNDO data interpolated by the inverse method are used as initial conditions. Thus a variational inverse model (e.g. BRASSEUR 1991) is developed to create appropriate initial conditions using the BNDO data set. The interpolated fields (e.g. on figure 2) - exploited as initial conditions - lead to a better simulation of the general circulation, and a crude data assimilation scheme is implemented to improve the general pattern. This data assimilation scheme simply uses the surface values computed by the inverse model to calculate an additional surface flux with a tendancy to restore the surface values computed by the direct model to those computed by the inverse model. It will be shows that now the Algerian current is improved, the Liguro-Provencal current well established. In the Balearic Island region, the simulations do not create a coherent current system indicating either bad grid-resolution, initial conditions or a high mesoscale variablity. Indeed, the variational inverse method gave significantly better results by using seasonal averages than monthly averages in this region, suggesting thus an important seasonal signal and high mesoscale variablity.

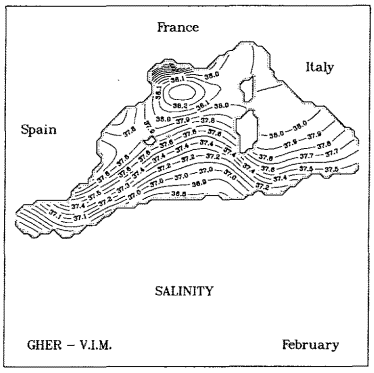

Fig. 2: Surface salinity field in February reconstructed by the variational inverse model from the BNDO data set.

In the near future, more sophisticated data assimilation schemes will be tested, in order to use a high resolution model with accurate data.

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The Algerian Current Instability: Analytical and Numerical Investigation

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(2) IBM UK Scientific Centre, Winchester UK.

It is well known that the Atlantic water, after a trip around the Alboran Sea gyre(s), flows (guided by the Corilis force) along the Algerian coast as a light water intrusion. This current is unstable, and mesoscale activities generate cyclones and anticyclones, but only the latter ones grow enough to separate from the mean flow.

In order to demonstrate that the GHER 3D mathematical and numerical model is able to reproduce the eddies and instabilities of the Algerian current, an academic test case has been studied. Initially we have a dense water ocean with a southern coast. Along this coast flows a lighter water intrusion in geostrophic equilibrium (Fig.1).

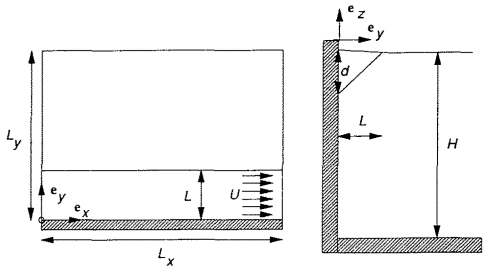

Fig. 1.- Base current

The geometrical and physical values are choosen in such a way that the transport in the lighter water is about 1.4Sv, corresponding to a typical value of the Algerian current (MILLOT, 1991). The boundary conditions in along-shore direction are periodic, which of course triggers the instabilities of a particular wavelenght.

The analytical solution shows that this current is stable in the framework of a reduced gravity model. The question of the type of the instability arises, because nature and direct simulation show strong instabilities.

The numerical grid uses a 2.5kmx2.5km horizontal Arakawa C-grid, with a vertical discretization of 17 levels, with a higher resolution in the light water mass. The time step was 2s for the barotropic part and 240s for the baroclinic one. The day to day variation of the shore current is shown, which gives a nice illustration of the instability growth and the development of an anticyclone accompanied with filaments spreading into the basin. After 50 days, the anticyclone ends up with a diameter 3 times larger then the initial current width, and its centre stays more or less at rest. Figure 2 shows the salinity field as computed after 55 days of simulation.

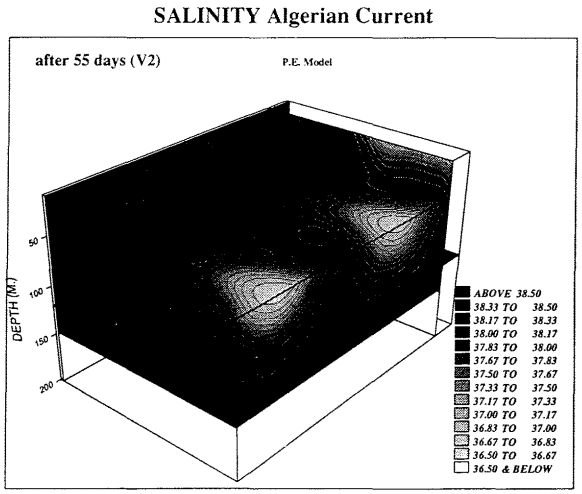

Fig. 2.- 3D view of the Salinity field in the periodic channel. The 3D view is from south-west to north-east. One can clearly see the big anticyclone.

One may question if other boundary conditions than the periodic ones would move the anticyclone northward, or if real topography should be included for this purpose.

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Waves and wave groups in shallow water : numerical and field results

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Random waves and wave groups on deep water can be closely reproduced through the superposition of linear component waves with amplitudes determined from the target energy spectrum and with uniformly distributed random phases [1]. A spectral form usually adopted to represent random waves on deep water is the JONSWAP one. This stochastic random wave simulation technique can be applied also to shallow water when the local spectral forms are known and the non linearities are taken into account.

In this study the behaviour of the random waves and wave groups on shallow water deduced by non linear numerical simulations is compared with the one deduced by field shallow water data excluding the surf zone.

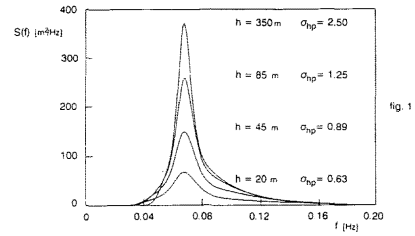
The local spectral form on shallow water was obtained by the transfer of the JONSWAP spectrum on deep water [2]. The shallow water frequency spectrum so obtained (fig. 1) presents a single peak even for very shallow water, while both theory and experiments support the occurrence of a secondary peak in the shallow water spectrum due to the increased importance of the nonlinearities. So a model was performed to give the 2nd order component of the vertical displacements η_2 starting from the 1st order ones η_1 with a perturbation method [3]. Fig. 2 shows η_1 and $\eta_1+\eta_2$ obtained with the nonlinear numerical simulations starting from the spectrum on the lowest depth in fig. 1.

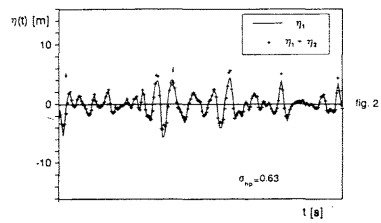
The field data were recorded for ten minutes every four hours by a pressure gauge placed on six meters depth offshore Massa, on the Tuscan coast. The data, consisting of vertical displacements and current velocities and directions on the bottom, were collected for Ministry of Public Works during the whole year 1989, in order to monitor the erosion of the shoreline. A preliminary selection of the sea states was made to avoid disturbances and breaking waves through a check of the autocorrelation function of the vertical displacements. The field sea states were analyzed with the spectral density method in order to compute their peak frequency f_P, and then selected through the value of the dimensionless parameter

$$\sigma_{hp} = 2\pi f_P \; h/g$$

h being the depth and g the gravity. The recorded sea states for which the value of σ_{hp} differed more than ±10% from the value 0.63 of the simulated ones were rejected.

For both the simulated and field sea states the wave groups were identified with a discrete approach based on the individual waves obtained by the zero upcrossing method. The length of the wave groups, that is the number of individual waves exceeding a given threshold, and the energy density of the groups were computed for both the simulated and recorded waves on shallow water, and the relevant results were compared.





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O

Some mesoscale features in the Algerian Basin

Mejdoub BENZOHRA, Claude MILLOT and Isabelle TAUPIER-LETAGE

Antenne COM, LA SEYNE/MER (**France**)

Scarce and compiled data, over several decades, do not account for the powerful mesoscale phenomena which drive the circulation in the Algerian Basin, that has led, in the past, to some misleading analysis of the water mass circulation in this region. These historical schemas have been reconsidered by means of hydrological and remote sensing observations, emphasizing the role of these mesoscale phenomena on the distribution of the various water masses in the Algerian Basin (MILLOT, 1987-a).

Indeed, the Médiprod-5 experiment. mainly based on one-month cruise hydrological data, surface buoy trajectories and 9 month-duration current meter observations at various locations and depths (100. 300, 1000 and occasionally 2000 m) has clearly pointed out the strength of the mesoscale activity and the role it plays in the distribution of the various parameters at sea (MILLOT, 1987-b, BENZOHRA and MILLOT, 1992-a,b). In MILLOT *et al.* (1992-c) we have clearly shown that such mesoscale phenomena are generated by the baroclinic instabilities of the Algerian Current. In the following we describe two such mesoscale phenomena; the first one (eddy O) by means of hydrological data and buoy trajectories, and the second one (event E) by means of SST signatures and current meter observations.

Eddy O has been sampled along a transect perpendicular to the coast at 4°40'E. and has its center at ≈150 km off the coast, with a diameter of ≈120-140 km, depressing the isolines by ≈150-250 m. Inside it, we have identified the major water masses one encounters in the western Mediterranean: the MAW which appears mainly as streamers at the surface, the WIW and the LIW, at mid-depth, which are the less mixed in the region. This accounts for the fact that such waters have been incorporated by complex entrainement processes from the area where they are usually found (the Algerian coast, the northern basin and the Sardinian slope, respectively for MAW, WIW and LIW). A striking feature the O-S diagrams have revealed, below the seasonnal thermocline, is the presence of a nearly homothermal lens of cooled MAW, ≈50 km in diameter, extending to a depth of 200 m. It is completely isolated from the surrounding waters and stands between the maxima of the current which extend at depth. We have concluded that such a lens of water means that the eddy has experienced at least one winter, estimating eddy O is several month old at least.

Dynamically, eddy O interacts with the Algerian Current, deflecting at least all the MAW layer seawards from its eastwards course towards the Sardinian Channel. The dynamical topography at 300 db (the level where LIW is usually found) shows complex interactions where onoffshore exchanges seem to occur. This leads to the enhancement of the characteristics of older LIW, we have previously hypothesized to flow eastwards along the Algerian slope, by mixing with the more recent LIW which is found mainly offshore.

The computation of the integrated available potential and kinetic energies leads us to think that eddy O is not in decaying process, and the radial distribution of these quantities shows clearly that it stores its energy from the Algerian Current.

We have been lucky to follow the growth and the eastward drift of an instability (named event E) during the Médiprod-5 experiment. It mainly consists in a meander of the Algerian Current of ≈100 km in through, enclosing a superficial anticyclonic eddy of 70-80 km in diameter, well evidenced by satellite images, and soon generating in the whole deeper layer an intense anticyclonic eddy having a diameter of ≥150 km in width, propagating eastwards along the Algerian continental slope at ≈3 km/day. Continuing its eastwards course, such a structure might become detached from the Algerian coast, becoming an open sea eddy as eddy O.

These two examples have given us the opportunity to set forth the role of the mesoscale phenomena in the distribution and circulation of the water masses in the Algerian Basin. The origin of such phenomena appears to be related to the growth of the Algerian Current instabilities via conversion of available potential energy into kinetic energy as it appears from our measurements and results inferred from numerical and physical models (CHABERT D'HIERES *et al.*, 1991; MORTIER, 1992).

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O

Upper layer circulation of the Marmara Sea

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The upper layer circulation of the Sea of Marmara during periods of high and low fluxes from the Black Sea (during October 1991 and March 1992) was determined from a combination of velocity and hydrographic data. Velocity data were obtained with a 150 Khz vessel-mounted Acoustic Doppler Current Profiler (ADCP) on board the R/V Bilim. ADCP measurements were carried out at fixed oceanographic stations and during cruising.

During the period of high discharge (March 1992), northierly winds were dominant, and the surface currents were mainly directed southward along the Anatolian coast. At exit into the Sea of Marmara from the Bosphorus, current velocities reached 300 cm/s and were on the order of 20 cm/s elsewhere in the anticyclonic circulation of the Sea of Marmara.

The upper layer flow exiting from the Bosphorus was not well defined during the low discharge period of October 1991. The exit flow was initially attached to the western side and followed the Thracian coast, while the basin general circulation was anticyclonic.

Seasonal Variability of the Eastern and Western Mediterranean Circulation derived from historical data.

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The Eastern and Western basins of the Mediterranean Sea have been the seat of multiple and intense - although fragmented in space and time - observing networks and hydrographic surveys, delivering a substantial amount of information about the general circulation.

In most cases, these data sets have been interpreted individually, in order to investigate regional processes, isolated mechanisms or local hydrographic regimes. The main objective of this study is to construct a unified data set, - using as many *in situ* observations as possible -, to analyse them globally and to extract the seasonal signal of the circulation consistent with the historical data.

The variational inverse method (BRASSEUR and HAUS, 1991) has been applied to reconstruct the three-dimensional temperature and salinity (or density) fields representative of the four seasons. The solutions are derived from a variational principle, taking into account the statistics of the observations to minimize the expected error on the fields. Additionally, a kinematic constraint is shown to be equivalent to anisotropic correlations between the data, as a result of the advection of the scalar properties by the geostrophic circulation.

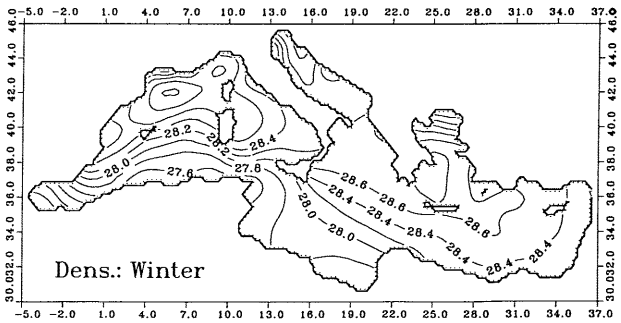

Fig. 1.- Surface density representative of the winter season.
Optimal solution produced by the variational inverse method.

At the seasonal scale, the distribution of the sations is relatively homogeneous and it is possible to observe correctly the seasonal signal in temperature and salinity. Heat and salt budgets are computed for the different water masses and the seasonal volume variations of the surface layer and intermediate water mass are represented.

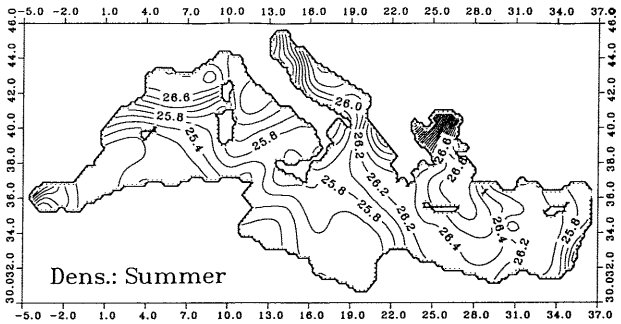

Fig. 2.- surface density representative of the summer season.
Optimal solution produced by the variational inverse method.

At the monthly scale, the stations are typically too sparse to reproduce a significant month-to-month variability from the observations only. Gaps between the data points must be filled in, using a realistic dynamical procedure to interpolate in space and time.

The assimilation of the results of the variational inverse method in the GHER primitive equation model (BECKERS, 1991) is tested using a very simple "restoring" scheme at the surface. The implementation of a more sophisticated procedure (derived from the Kalman filter scheme) is currently investigated.

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Flow through the Strait of Gibraltar

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A major change in the understanding of the dynamics of flow through straits has occurred over the last few years due to the development of two-layer hydraulic control models and due to new observations of the exchange between the Atlantic and Mediterranean through the Strait of Gibraltar. From the theoretical models, predictions of the outflow of Mediterranean water, the inflow of Atlantic water and the salinity difference between the two water masses can be made for the specific configuration of the Strait of as a function of the net evaporation over the Mediterranean basin. Time series current and salinity observations on the Gibraltar sill during the 1985-86 Gibraltar Experiment determine the actual outflow, inflow, outflow salinity transport, and salinity difference. The observed outflow salinity transport provides a nearly direct estimate for the net evaporation over the Mediterranean basin of 52 cm/yr, that may be more accurate than the usual climatological estimates. The observed inflow is 0.68 Sv and the best estimate of the outflow is 0.72 Sv, with a salinity difference of 2.2 ppt between the inflowing and outflowing waters. For such a net evaporation, predictions of the inflow and outflow transports and the salinity difference between them from hydraulic theory are in reasonable agreement with the observed values, though the theoretical predictions for the transports are about 20% larger than the observed values. Given that present theory does not include important dynamical effects such as rotation and friction that could lower the predicted exchange, the agreement within 20% between the observed and predicted exchanges through the Strait of Gibraltar is encouraging.

O

Seasonal transports in the Strait of Sicily: updating results

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Two opposite currents move in the Strait of Sicily: one of Atlantic Water mainly concentrated in a meandering jet and mesoscale gyres seen along a frontal structure which is observed at the boundary of surface water on the Sicily shelf; the other current is of Levantine Intermediate Water below the depth of 150-200 m. It follows the bottom topography and flows into the Western Mediterranean over the sills the deepest of which, North of Pantelleria Island and deep 435 m, is certainly the more important.

The AW and LIW transports through the Strait represent an important element to be considered when modelling the East Mediterranean circulation. Attention is called upon their seasonal and interannual variations because of their links with the climate of the area, as the marine physical conditions depend upon the changing climatic forcing over the Mediterranean sea and the Atlantic Ocean.

In steady-state conditions, admitting salt and mass conservation of the Eastern Mediterranean basin, the transports and the mean salinities in the Strait are related to the water deficit by:

$$Q_{LIW} = \frac{D}{\rho_{LIW}} \frac{\langle S \rangle_{AW}}{\langle S \rangle_{LIW} - \langle S \rangle_{AW}} \qquad \frac{Q_{LIW}}{Q_{AW}} = \frac{\rho_{AW}}{\rho_{LIW}} \frac{\langle S \rangle_{AW}}{\langle S \rangle_{LIW}}$$

Assuming in the Strait the same linear behaviour between the core salinities of both water masses, which are practically constant and namely $S_{AW} = 37.00$, $S_{LIW} = 38.75$, then

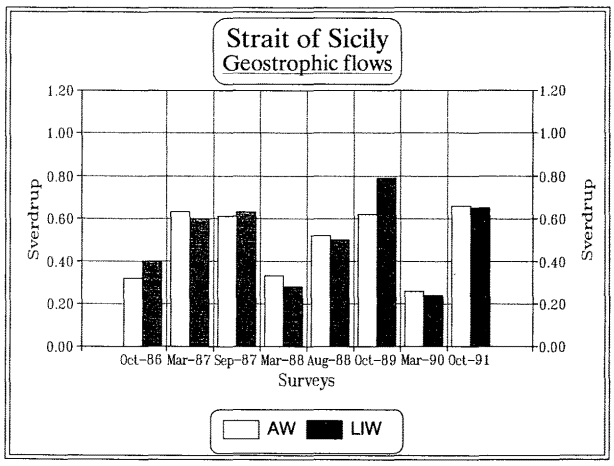
$$Q_{LIW} \approx 20\ D$$

The value of $D = 2 \times 10^3 km^3 y^{-1}$, considered as a realistic approximation of the water deficit in the East Mediterranean area, involves the transport of one Sv.

In the framework of the project POEM (MALANOTTE-RIZZOLI, 1988, ROBINSON *et al.*, 1991, MORETTI *et al.*, 1992), seasonal TS measurements were performed in the Strait with greater concern to a cross section north of Pantelleria in order to evaluate the water transport. The computations gave results spanning between 0.3 and 0.8 Sv.

During the survey of October 1991 the section was somewhat extended and adjiusted with respect to the former in order to obtain a better estimate of the dynamics over the Tunisian shelf. The new result, 0.6 Sv, may be also considered valid for old sections. The graph below reports all the data.

The observed variations of Q_{LIW} estimated as above, confirm a noteworth seasonal variability of the water deficit in the Eastern basin so evidencing the presence of the East basin climate signal.



A part of the next survey will be devoted to test the possibility of obtaining long current time series in front of the severe environmental conditions of the area. They are necessary for a more exhaustive discussion.

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Modelling the Surface Circulation of the Eastern Mediterranean Sea

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A primitive equation OGCM (Ocean General Circulation Model), see CANDOUNA (1991, [1]) is used to study the circulation of the Eastern Mediterranean Sea and its seasonal variability. The model domain extends westwards to 15°E and northwars to 40°N. Straits and channels are artifically assumed to be closed at all boundaries. The initial and upper surface boundary conditions are prescribed by the monthly mean temperature values and the annual mean salinity values of the climatological LEVITUS data set, LEVITUS (1982, [3]), while the atmospheric forcing by the HELLERMAN and ROSENSTEIN climatological windstress data set, HELLERMAN and ROSENSTEIN (1983, [2]).

The run becomes quasi-stationary after 20 years of integration and the spin up time is about 12 years. Large-scale circulation patterns, such as the Mid Mediterranean Current (MMC), the Ionian Atlantic Stream (IAS) and the Cilician Current can be succecfully simulated by the model. Inconcistencies in the circulation pattern are located where mesoscale eddies are expected; e.g. the West Cyprus Cyclone (WCC) in the northwestern Levantine Basin, the Cretan Sea Cyclone (CSC) and the Rhodes Cyclone (RC), southwest and southeast of Crete. The model forms an anticyclonic eddy at the same location of the Shikmona Anticyclone (SA), but however, there is not any indication of an eddy at the location of the Mersa-Matruh Anticyclone (MMA).

The OGCM used in this study has been developed by Dr. E. MAIER-REIMER at the Max-Planck-Institut for Meteorology. The numerical experiments have been performed there too, as part of the author's M.Sc. thesis.

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Inertial waves and tidal motion in the Ibiza Channel

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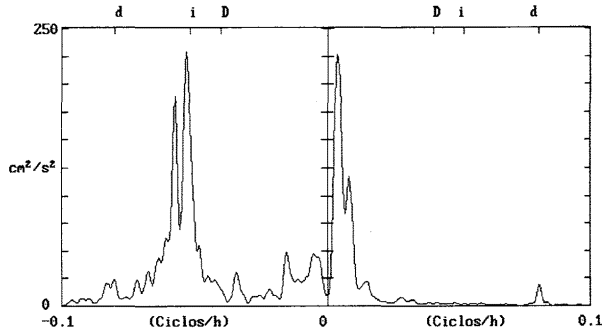
From the fifteenth of November 1990 to the twenty fourth of July 1991, and as a part of the programme "Dynamic Study and Biological Production of the Ibiza Channel", six current meters were moored in the Ibiza Channel (38°49.3' N, 0°47.9' E) at depths, 90, 115, 165, 265, 465 and 715 meters, in order to study the water mass fluxes through the Channel.

Current meters were placed in two successive moorings, the first one goes from the beginning to the fifteenth of March 1991 and the following one from the twentieth of March 1991 until the end.

Preliminary results from the analysis of the recorded data are presented here. Well differentiated peaks close to the inertial frequency and a weaker one, related to the semidiurnal tide, are observed in the spectrum (See Figure). Tidal ellipses have practically degenerated in straight lines, as it can be observed in both, figure and table.



Rotatory spectrum (negative frequencies correspond to the clockwise rotation) at 115 m. depth.
Letters **d** and **D** denote the semidiurnal and diurnal frequencies bands, respectively; **i** corresponds to the inertial frequency.

A harmonic analysis at the various depths shows a no very intense signal but easily detectible corresponding to M_2, clearly barotropic and with the tidal ellipse oriented according to the N-S axis of the Channel (See Table).

Table: Tidal current ellipses of the M_2 constituent in the Ibiza Channel (38°49.3' N, 0°47.9' E). Phase is referred to Greenwich meridian. A denotes anticlockwise rotation. C clockwise rotation.

Depth (m)	Major semiaxis (cm/s)	Minor semiaxis (cm/s)	Orientation (0° eastwards)	Phase	Rotation
90	1.3	0.2	104	138	A
115	1.6	0.0	93	145	-
165	1.5	0.2	102	144	C
265	1.8	0.2	91	144	C
465	1.5	0.2	93	145	C
715	1.4	0.2	65	147	C

The spectral analysis shows a more intense inertial peak centred at 0.054 c/h., a 4 percent larger than the local inertial frequency (0.052 c/h.), with clockwise rotation sense.

A previous analysis of this peak of frequency indicates a phase propagation for these waves of the order of 0.01 cm/s. The vertical wave length is of the order of 200 m.

Inertial currents are more intense at the three first levels of depth, decreasing very rapidly below the 200 m. level.

A particular characteristic of the spectra, more noticeable at the three superficial levels, is the appearance of a second peak on the frequency 0.058 c/h. which we think is due to a modulation of period $(0.058\text{-}0.054)^{-1}$ hours (10 days approximately) in the inertial waves, related possibly with the variations in the wind impulses.

Air-sea Interaction Fluxes of the Mediterranean Sea

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This work presents monthly analysis of the heat and momentum fluxes for the Mediterranean Sea for the period 1980-1988.

The upper ocean thermodynamics must be well represented in the Mediterranean since it is a mid-latitude basin with intense buoyancy fluxes (high evaporation and sensible heat flux transfer). This work shows the total heat budget of the basin calculated with standard bulk parameterization formulas from available atmospheric and oceanic data sets.

The monthly, seasonal and interranual variability of the atmospheric forcing parameters is also known to be important in the Mediterranean region and it is clearly expected to have important effects on the oceanic flow field. Thus we also analyze the seasonal and interannual variability of the heat and momentum fluxes.

The main data source for this work is the NMC data set for the surface atmospheric quantities (wind components, air temperature and relative humidity) and the "Reynolds SST data" for the sea surface temperatures. All these basic fields, processed and analyzed, have been set up for the interested region. Also we had available monthly cloud data, that allow us to calculate the fluxes under cloudy sky conditions.

We used bulk parameterizations for the sensible and latent heat and parameterizations for incoming short wave radiation and net outgoing long wave radiation. The same formulas and atmospheric parameters have been used to force a general circulation model (GCM) of the world ocean and of the Mediterranean Sea. We followed the heat flux computations used by ROSATI and MIYAKODA (JPO,1988), that seemed more appropriate in forcing the GCM.

We calculated both clear and cloudy sky heat fluxes, the momentum fluxes and also the curl of the wind stress for each month of the aforementioned period along with time series of these quantities averaged on the surface of the Mediterranean basin.

The results show the strength of the latent heat flux on the net total flux, that confirm the fact the Mediterranean is a strong supplier of moisture over the year. The overall long term time mean of the net surface heat flux at the sea surface integrated over the Mediterranean area is $95W/m^2$ which is clearly unrealistic for this area. However if we use the sea surface temperatures simulated by the GCM and we compute the same net heat budget we get only $7W/m^2$. This points out to the importance of adequate resolution in the ocean SST (the model has 1°/4 horizontal resolution) to give realistic heat budgets at the air-sea interface. Our work also shows the existence of high heat anomalies during the summers 1987-1988, due to very high air temperature in summer expecially in the Eastern Mediterranean basin. Sensible and latent heat fluxes show 2 to 3 standard deviations anomalies in this region and time of the year. During the winter 1981 we show very anomalous wind amplitudes associated also to an exceptionally strong Mistral event and very strong wind stress over the Ionian basin.

O

Experimental investigation of some wave spectral parameters transformation in the Coastal Zone

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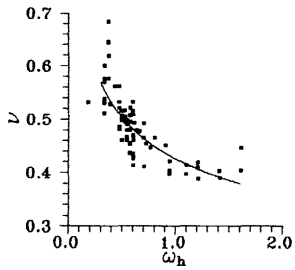
The scope of this work is to analyse experimental data on wind waves in the surf zone, in order to establish the variation of the spectral parameters on which the distribution of wave height depends. All data used here have been gathered in "WAVE'90" near-shore experiment, conducted at the Institute of Oceanology of Bulgarian Academy of Sciences.

Sea surface elevation has been measured at eleven fixed locations with a depth of 18m to 1.3m. Data have been sampled each 0.165s in a 15min period every 3 hours, coresponding to the first stages of two storms. Although there are broken waves in shallower water records, all series have been analyzed in the same manner.

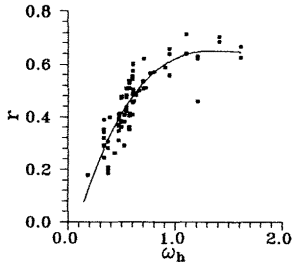
TAYFUN (1990) shows that wave heights density in deep water depends on the parameter $r(\tau) = (R^2 + R2)^{1/2}\ m_o^{-1}$, where $R(\tau)$ and $R(\tau)$ are an autocorrelation function and its Hilbert transformation, m_o is rms surface elevation and τ is the half value of the mean wave period.

For narrow spectrum LONGUET-HIGGINS (1984) has obtained an aproximate relation between r and υ, where υ is the dimensionless bandwidth parameter. Analysing $r(\tau)$ transformation we are able to investigate the transformation of distribution of wind wave heights. Experimental researches of $r(\tau)$ transformation in the coastal zone are unknown to us.

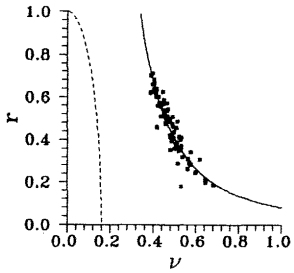
The above spectral characteristics are calculated for 71 recordings of elevation. Variation of r and υ is obtained in dependence of $\omega_h = \omega_p\ (h/g)^{1/2}$, where ω_p is the spectral peak frequency, h is the depth and g is the gravitational acceleration. The figures bellow demonstrate that the parameter υ becomes great and $r(\tau)$ becomes less with decreasing of the ω_h.There is a strong dependence between r and υ.



Experimental data for ν as a function of ω_h for both broken and unbroken waves in the coastal zone.



Transformation of r in the coastal zone.



Experimental data for r as a function of ν for the spectra of wind waves in the coastal zone. The dashed curve respresents asymptote $r=(1-4\pi^2\nu^2)^{1/2}$ for the narrow processes - according to Longuet-Higgins (1984).

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Field studies of subduction phenomenon in the Black Sea

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Until recently, it was considered that cold intermediate waters of the Black Sea are formed due to winter convection on the shallow northeast and northwest shelfs of the basin. Field Studies during early 80-th provided evidence for the fact that cold waters are formed also over the domes of cyclonic gyres in the central part of the basin (OVCHINIKOV & POPOV, 1984; LATUN & YASTREB, 1986).

In 1991-92, several cruises were conducted in the northern part of the Black Sea in order to study the process of CIW formation and of their further transformation. In March, there were three regions, sources of CIW that could be distinguished due to the properties of the cold layer. At the N-W, water temperatures were about 5. 5 x C and E was less then 14. 0 due to low salinities. Waters with minimum temperatures (about 5.0 x C), starting from Kerch strait, formed a thin stripe along the coast of the Crimea.

Over the domes of cyclonic gyres, minimum temperatures were about 6.1-6.3 x C (lower temperatures were observed in the east). Density of these waters reached 14.6 E units due to high salinities Thus, the final CIL is formed by waters with different properties due to subduction.

Waters were well ventilated down to 14.5 E interface in cyclonic gyres and on the left side of the Rim current. In anticyclonic feature, west off the Crimea, newly generated waters reached only 14.3 E interface. In this pattern, the traces of the former CIL were observed within the main pycnocline. Temperatures of this former CIW were about 7.5-7.6 x C and dissolved oxygen concentrations reached 5.0 m/l. Comparing these results with autumn data, we obtain an estimate of CIW transformation and the rate of downwelling (the rate of subduction) in the observed anticyclonicpattern (about 10 m per month).

Study of the 3-D circulation in the Ligurian Sea during the Haven disaster

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During April 1991 the Haven tanker discharged accidentally 15,000 tons of crude iranian oil in the Ligurian Sea. During the activity related to the monitoring of the spill effects on living resources a large amount of data where gathered, using different platforms and sensors; AVHRR, TM, SPOT, Daedalus, shipborne IR Radiometer, Pyrgeometer, CTD, Current meters. Those data contributed to the definition of the circulation current field during the accident. Numerical experiments were carried on for the simulation of the circulation pattern, oil spill dispersion, weathering of the oil and sinking. The general cyclonic circulation existing in the Ligurian Sea was influenced by wind forcing, which was responsible of small scale instabilities evolving in a rather complex eddy structures. Numerical experiments were able to describe the importance of the topography on the circulation, as well as the vertical density structure. The numerical model adopted was semi-emplicit, allowing a large time step. Model simulation was validated by a comparison with the time evolution of the thermal features observable in a time series of AVHRR images. In situ radiometer measurements allowed the geophysical validation of AVHRR satellite data in case of presence of oil.

The Heat Content Changes in the surface layers of the Ligurian Sea during October 1978

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The knowledge of heat content in the sea and its space and time variation is of importance in many atmospheric and oceanic dynamical processes. Estimations of oceanic heat content and heat budget on climatological and large spatial scale can be found in literature, but there is a general lack of information about the total heat budget on regional and synoptic scale.

An attempt to estimate surface heat budget, heat content variation and advection from currents during October 1978 in the Ligurian Sea is performed.

Two hydrographic sections, Genova-Capo Corso and Imperia-Capo Corso were repeated three times during October 1978; 52 Temperature, Salinity and Density profiles through a depth of 400 m. were collected. Meteorological and global solar radiation data for the whole period were provided by Genova and Imperia Meteorological Obsevatory; other meteorological measurements were performed on board during the three oceanographic cruises.

Heat storage computation was performed for each station at different levels by :

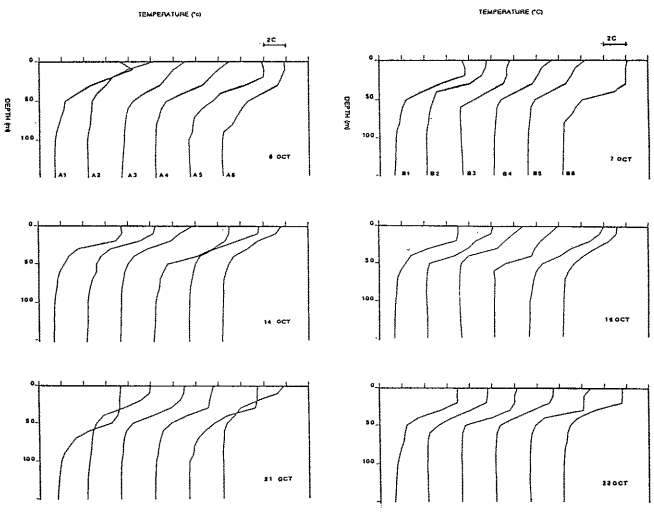
$$Q = Cp\, e\, T\, Dz$$

Cp sea water heat capacity = 4000 J/°K
e mean density
T mean potential temperature
Dz layer thickness

Vertical resolution was 10 m in the upper 100 m, 25 m between 100 m and 200 m and 50 m between 200 and 400 m.

Surface heat balance were estimated by using bulk formulas and heat advection by means ofcomputed geostrofic currents.

Fig.1 reports six vertical temperature profiles in the section Genova-Capo Corso (A) and Imperia-Capo Corso (B).



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O

The mean, trends and interannual variability in Mediterranean Air-Sea Interaction

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The semi-enclosed nature of the Mediterranean Sea makes it an excellent place to test data sets and formulae, for air-sea interaction, that may be applied globally. In particular, we have used COADS (the Comprehensive Ocean Atmosphere Data Set) for 1946 to 1988, together with standard heat flux formulae, to examine the heat budget of the Mediterranean.

The initial estimate of the long term mean heat input is 36 W/m^2 higher than is compatible with the exchange through the Strait of Gibraltar; it is important to establish which component of the heat flux is responsible for this imbalance. An adjustment of the latent heat loss to make up the difference seems implausible as this would require a doubling of the rainfall over the Mediterranean to be compatible with the freshwater budget of the Sea. The heat imbalance may be partly due to an underestimate of the longwave back radiation, but it seems unlikely that all of the discrepancy can be accounted for in this way. Thus, as the sensible heat flux term is small anyway, we are reduced to ascribing most of the imbalance to an overestimate of the insolation, possibly due to the influence of marine haze. Direct measurements of insolation at sea are thus required, as well as improvement of the other terms in the heat and freshwater budgets.

An apparent trend in the COADS wind speed appears to be due to a change in observing practice (from sea state observations to anemometer measurements) which is difficult to allow for precisely. Thus any real trend in the total heat flux is difficult to establish, though COADS does show a downward trend in the insolation of about 5 W/m^2 over 40 years due to an increase of about 10% in the cloudiness.

COADS implies an interannual variability in the annual average total heat flux with a range of about 30 W/m^2, implying changes in the total heat content of the Mediterranean that might be detectable with historical hydrographic data. If these are not found the global application of COADS and standard formulae in variability studies will be further weakened. Much of the heat flux variability comes from changes in the latent heat flux term, with contributions due to variations in the humidity of the air and the saturation humidity at the sea surface temperature.

We have also examined the net buoyancy flux from the sea, finding that contributions from run-off and precipitation are important for the long-term mean, but insignificant for seasonal and interannual variability. In some years the net buoyancy flux is "estuarine" rather than "lagoonal", but a reversal of the average circulation would require larger changes in the heat or water budgets than seems plausible without major climate change.

We have extended our analyses of COADS to consider such things as interannual variability and spatial patterns of the fluxes and welcome further suggestions. In turn, we can help plan the future measurements and modelling studies that will improve our understanding of this fascinating sea.

Formation and Circulation of the Intermediate and the Deep Waters of the Mediterranean Sea

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Formation and circulation of intermediate and deep waters in the Mediterranean Sea is a broad topic implying many complex dynamical and thermodynamical processes, most of them being unknown up to now.

During the last ten years, a major discovery regarding these problems, has been undoubtedly the recognition of ubiquitous mesoscale eddy features in all the basins of the Mediterranean Sea:

- cyclonic and anticyclonic eddies associated with the Algerian and the Ligurian currents (MILLOT, 1991)
- complex patterns of circulation in the eastern Mediterranean Sea (ROBINSON *et al.*, 1991)
- cyclonic eddies around the Alboran anticyclonic gyre (TINTORE *et al.*, 1991)

to name a few. This is not too peculiar to the Mediterranean Sea since similar features had also been discovered 20 years ago in other oceans like the Atlantic Ocean for instance.

Obviously these widespread and intense mesoscale eddy features in the Mediterranean Sea must be clearly understood in order to make progress regarding formation and circulation of water masses such as Levantine Intermediate Water and Western and Eastern Mediterranean Deep Waters.

Concerning the deep convection and formation of Western Mediterranean Deep Water, the importance of the mesoscale had already been recognized a long time ago during the Medoc experiments (GASCARD, 1978), (KILLWORTH, 1979). More recently attention has been focused on three aspects all related to deep and bottom water formation:

- θ/S variability in bottom water characteristics (LACOMBE *et al.*, 1985)
- Small scale phenomenom ($u = v = w = 10$ cm/s; $x = y = z = 1$ km) influenced by atmospheric forcing (SCHOTT and LEAMAN, 1991)
- large scale barotropic circulation strongly influenced by bottom topography (MADEC *et al.*, 1991).

These three aspects should now be integrated in order to progress in our complete understanding of deep and bottom water formation processes. As noticed by (LACOMBE *et al.*, 1985), the phenomenom of variable bottom water and the processes which produce it, may be relevant to our understanding of water formation.

Last but not least, significant progress has been made during the past ten years in strait dynamics mainly in the strait of Gibraltar (ARMI and FARMER, 1988), (FARMER and ARMI, 1988) but also in the strait of Sicily. The importance of these straits for the general circulation of water masses and their formation in the Western and Eastern Mediterranean Seas, is now better understood (BRYDEN and STOMMEL, 1984). The variability in transport through the strait of Sicily compared with the much more stable transport through the strait of Gibraltar is quite intriguing.

Most of these new discoveries are resulting from observations, but in some cases they are also confirmed by numerical modelling. In this presentation we will try to review these new aspects thoroughly. Based on past observations, high resolution 3D numerical models, and advanced technology, we will also indicate new perspectives in the monitoring of the Mediterranean sea that should allow us to envision the construction of an operationnal model by year 2000.

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O

Visualisation Possibilities for the Interpretation of Dynamic Phenomena and Complex Oceanographic Data

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Analysis of the already huge and still increasing amount of available data, both simulation results and real data, remains a difficult task. Visualisation is a fast and powerful approach making efficient use of the enormous capabilities of the human brain for image interpretation.

The projection of 3D (or 4D) multi-variable fields on a 2D picture needs careful attention to the type and number of represented variables, adequate use of symbols and colours in order to provide the observer with as much information as possible while avoiding overloading.

Using the results of the GHER direct and inverse models, it has been successfully applied to practical examples dealing with the Mediterranean Sea like study of regular 3D scalar or vector fields (salinity, velocity,...) location of 3D structures (water masses : spreading of Levantine Intermediate water in WMED)simultaneous representation of different variables and search for correlations, streamline analysis, direct representation of scattered real data (CTD stations) allowing fast interpretation and making easier error detection.

Most of all, the representation of time evolution through video animations is of particular interest for understanding of dynamic phenomena as it has been shown with the study of a test case (using the GHER mathematical and numerical model) of the instabilities development in the Algerian Current. Or for the assessment of seasonal variations in the Mediterranean (based on results of the GHER variational inverse model).

The NRL Mediterranean Sea Model

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The circulation in the Mediterranean Sea is extremely complex, consisting of numerous eddies and current meanders, particularly along the north African coast, in the Algerian basin and throughout the Ionian and Levantine basins. Satellite IR and CZCS imagery as well as recent hydrographic surveys (for example the POEM program) reveal a picture of the general circulation in the western and eastern Mediterranean consisting of sub-basin-scale gyres and interconnecting jets. There are many physical factors which exert an influence on the dynamics of the circulation of the Mediterranean Sea; wind stress, hydraulic controlled inflow/outflow through the Straits of Gibraltar and Sicily, intermediate and deep water formation, thermohaline forced circulation and topography.

Various versions of the NRL primitive equations ocean circulation model are used to systematically study the affects of these various forcing mechanisms, individually and in combination, on the circulation dynamics of the Mediterranean Sea. While the general results from various case studies involving wind, hydraulic, thermohaline and topographic forcing suggest that no one mechanism dominates the complex Mediterranean circulation and that non-linear interactions between the directly forced motions and internal flow instabilities play an important role, comparisons of model results from experiments using the ECMWF winds for the period 1981 to 1989 with observational data, both satellite IR and hydrographic, suggest that the winds play a major role in the evolution of the sub-basin-scale gyres seen in the Mediterranean Sea.

Model

The NRL multi-layer primitive equations ocean circulation model is a derivative of the HURLBURT and THOMPSON (1980) Gulf of Mexico model. A full description of the basic model is presented by WALLCRAFT (1991). The version used for most of the recent dynamical studies in the Mediterranean Sea is a three layer, finite depth, hydrodynamic, spherical coordinate version of the basic model. The model domain is presented in figure 1. The lateral boundaries for the model are taken at the 200m isobath. The initial layer thicknesses are take to be 200m for the upper layer representing the Modified Atlantic Water (MAW), 400m for the second layer representing the Levantine Intermediate Water (LIW) and the remainder in the third layer to the bottom topography representing the Mediterranean Deep Water (MDW). The inflow boundary condition was specified as a steady inflow of 1.2sv through the Strait of Gibraltar in the upper layer with conpensating outflow in the second layer. The formation of LIW is parameterized as a steady detrainment for the upper layer to the second layer in the eastern Mediterranean basin.

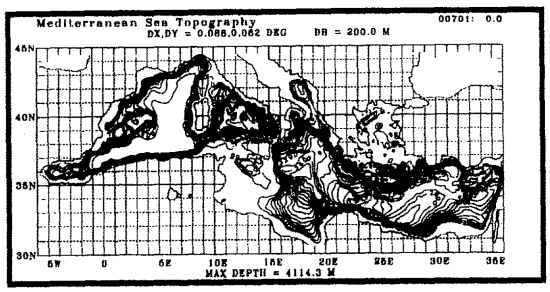

Figure 1.- Mediterranean Sea model Topography

The model was integrated to statical equilibrium using the HELLERMAN and ROSENSTEIN monthly mean wind stress climatology and then integrated for a nine year period with a hybred wind stress data set using the annual mean from the HELLERMAN and ROSENSTEIN climatology and the monthly mean annomallies from the ECMWF winds for the period from 1981 to 1989.

Results

The results from the simulations using the hybred wind data set have been comparied to satellite IR images for various time periods during the 1980s. The disappearance and reformation of the eastern Alboran gyre during July to August 1982 (HEBURN and LA VIOLETTE, 1990) is well represented in the model simulations. The mean annual cycle of the transport of LIW through the Strait of Sicily is replicated in the model simulations using the climatological wind forcing as well as in the simulations using the hybred wind forcing data set. The simulations using the hybred data set also show considerable interannual varibility.

The complex series of sub-basin scales gyres and meandering currents observed in the eastern Mediterranean Sea are shown in the model simulations as well. These features also exibit considerable seasonal and interannual variability. The gyres in the Ionian basin appear to be primarily wind forced with a definite annual cycle.

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Modelling of the general circulation in the Western Mediterranean Sea

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The 3D primitive-equation model of LODYC is used to represent the general circulation of the western Mediterranean sea from the strait of Gibraltar to the strait of Sicily. The model is initialized with the Levitus fields. The flux at the straits are not imposed, instead the Western Mediterranean Sea is linked to the Atlantic ocean and the Eastern Mediterranean Sea which are modelled by academic basins in which we use a newtonian relaxation to the initial density. We do not take in account atmospheric forcings. The results of this experiment show a realistic cyclonic circulation in the whole basin, the formation of intensified flows trapped to the coast. The instabilities of the Algerian current and the circulation of the Alboran sea are also well represented, and we can observe at intermediate depth a flow which at the exit of the Sicilian Strait turns right, enters into the Tyrrhenian sea following the Sicilian coast. This experiment also show that the Liguro-Provençal current appears without thermohaline forcing, it is created by the meeting of the western corsican current and the eastern one.

In further experiments we are going to introduce the atmospheric forcings, and to evaluate the influence of the different forcing: sensitivity experiments will be run.

All these experiments are made on a grid of 1/8°*1/10°, sufficient to adequately represent mesoscale phenomena.

A case of non-wind induced upwelling circulation in the Tyrrhenian sea, August 1991

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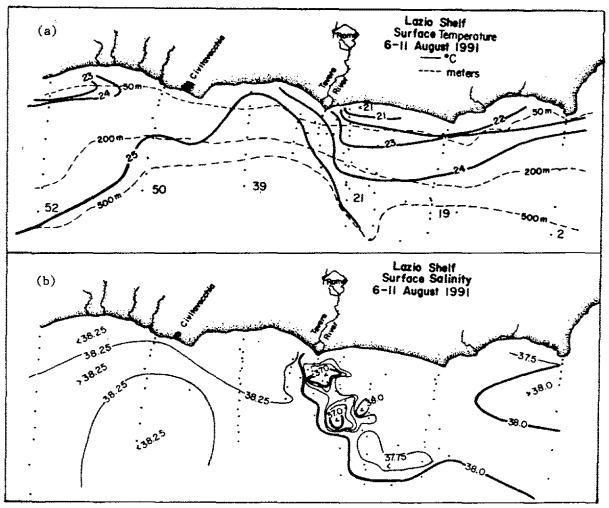
A hydrographic cruise was conducted on the R/V THETIS from 6 - 11 August 1991 in the Lazio Shelf region between the Islands of Ponza and Giannutri and from the coast out to a depth of 800 m (Fig. 1 a) by SoProMar as a part of a project with the Ministry of Merchant Marine to assess the impact of the Tevere River discharge. The circulation in northern Tyrrhenian is typically described as being dominated by a cyclonic gyre (e.g. KRIVOSHEYA and OVCHINNIKOV, 1973) and in wind-driven models (e.g. ARTALE *et al.*, 1992). While it appears to be an annually persistent feature, its scale and intensity vary in response to the wind field (ARTALE *et al.*, 1992) and to the strong seasonality of the Corsican outflow to the Ligurian Sea (cf. ASTRALDI and GASPARINI, 1991).

The cruise data revealed physical and biological conditions different from what is generally understood to be the normal summer situation. The nearshore zone (~5 km to 30 m) was uncharacteristically cooler than the offshore waters by 1-4°C (Fig. 1a) The Tevere plume was distributed slightly offshore to the south, (Fig. 1b), contrary to its normal tendency along the nearshore to the northwest. The hydrographic data indicated a net onshore flow onto the Lazio shelf (~2500 m^3/s), the difference between a strong onshore flow to the north and a weaker offshore to the south (Fig. 1c). The northwestern corner of the sampled regime appears to have included the cyclonic perimeter of the northern Tyrrhenian gyre as it was impinging on the shelf. In late July of 1991, satellite thermal imagery (BOHM, pers. comm.) suggested the gyre to have been relatively weaker until a 26-27 July westerly wind event that may have caused the gyre to intersect the Italian shelf further to the north than normal. The mean winds during the cruise were light ~2.5 m/s westerlies with a sea-breeze modulation of ~3 m/sec. It is suggested that these winds were insufficient to have set up and maintained the observed shelf circulation and that it likely was initiated by the preceding wind event and sustained by the anomalous offshore circulation. This work provides a preliminary discussion of the role of the circulation in the generation of the unprecedented quantity of mucilaginous algae observed during the cruise period.



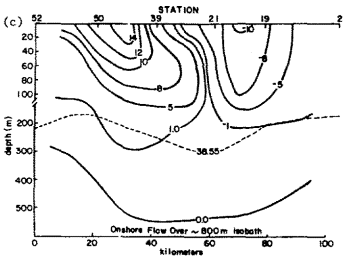


Figure 1
a) The surface isotherms during the 6-11 August cruise on the Lazio Shelf. The dots represent the stations sampled, and those numbered outer stations are referred to in Fig. 1c. The 50, 200 and 500 m bathymetric contours are shown.
b) The surface salinity contours.
c) The geostrophic onshore velocity component along the ~800-m depth contour (+ is onshore).

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Methods and means of organization of remote acoustic monitoring of the Black Sea and Mediterranean

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During last years it becomes inevitable that further progress in World Ocean studies is possible only with the use of principally new methods and means of ocean environment monitoring. The most useful can be the construction of hydroacoustical equipment for remote monitoring of ecological and hydrophysical processes for example in the Black Sea and Mediterranean. It is necessary to control, mainly, circulation the process of formation and variability of thermohaline structure, distribution of natural and anthropogenic particulate material, hydrochemical parameters, etc. The propose of observational system can be settled in case we can solve the following major tasks:

-to determine major mechanisms of sound dispersion, their specific peculiarities and their role in overall dispersion phenomenon;

-to access space-time structure of smallscale hydrophysical disturbances and their acoustic characteristics;

-to develop models of sound dispersion due to irregularities of different physical nature;

-to create physical base for remote sensing techniques of hydrofrequency acoustical diagnostic of hydrophysical processes;

-to study the possibility of monitoring of H2S boundary;

-to create a data base for forecasting conditions of sound dispersion in the water.

At present time, we developed a model of sound dispersion due to physical irregularities of sea water that takes into account it's complexity, spectral structure of irregularities and other factors. We have also studied the influence of temperature, salinity, current velocity peculiarities on characteristics of sound dispersion. Experimental studies have been conducted to investigate sound dispersion on temperature irregularities in a tank. These experimental results have confirmed theoretical studies.

Concerning experiments, special equipment and methodology have been developed for field acoustical measurements. Studies of sound dispersion characteristics and their relation to oceanological field structure has been performed, also.

Local dynamic experiment in the shelf zone of southern Crimean Coast

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Marine hydrophysical institute of the Ukrainian Academy of Sciences conducted local dynamic experiment (LODEX) in the shelf zone of Southern Crimean Coast (SCC) during the summer of 1991. The main objective of this experiment was to study the shelf flow dynamics in the presence of the developed seasonal thermocline. The principal forcing mechanism for the shelf flow in this region is a wind stress. According to this the main aims of the LODEX program were to investigate the physical processes caused by the local and remote wind forcing. Among them, an upwelling (downwelling) events and generation of subinertial coastally trapped waves are of a primary importance.

Experimental studies included:

1. Current and temperature measurements from 7 mooring buoys. Moorings were arranged along two lines oriented perpendicular to the local isobaths. One mooring buoy was placed upstream, another one was placed downstream from the experimental site.

2. Current, temperature and wind measurements from the oceanographic platform of the Experimental Department of MHI.

3. Current measurements from bottom installations on inner shelf (depths 10-15 m.). 4. 3 hydrological (CTD) surveys in the shelf-slope region of SCC from the RV "PROFESSOR KOLESNIKOV" (27 cruise), during which wind measurements and hydrochemical observations were perfomed as well. Surveys were organized as a system of sections which were oriented normally to the shelf break.

Obtained data have shown that the subinertial oscillations were well pronounced in the density and velocity fields on the shelf with periods of 11-12 days, 3-4 days and nearinertial one. Current oscillations at subinertial frequencies were better component, their amplitudes increased from the open sea to the coast and phase propagated from east to west which is in agreement with the properties of coastally trapped waves. These waves are essentially baroclinic because their propagation was accompanied by the temperature oscillations on the horizonts below the upper mixed layer.

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The EOF analysis of the Seasonal and Interannual variability of the Mediterranean General Circulation

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The purpose of this work is to study the seasonal and interannual cycle of the Mediterranean basin by analyzing the barotropic streamfunction's results of the Pacanowski, Dixon and Rosati version of Bryan and Cox's general ocean circulation model fitted to the aforementioned basin. The general idea is the separation of the time varying two dimensional streamfunction field stm(t,x,y) where x,y run all the model's grid points, in a temporal dependent and a spatial dependent component:

$$stm(t,x,y) = \sum_i T_i(t)\phi_i(x,y)$$

This target is achieved via an EOF analysis of the two dimensional streamfunction fields either for the Western or the Eastern sub-basin since these two areas can be considered as loosely coupled in the streamfunction field.

The practical computations aim at solving the eigenvalue problem $TG = GL$ where T is the nxn scatter matrix $T = DD^T$, G is the matrix of eigenvectors and L is the diagonal matrix of the eigenvalues. The data matrix D is a nxp matrix with elements stm(t,x) where t = 1,..,n indicates a time sampling scheme and x = 1 ,..,p a spatial sampling scheme.

The next step is the projection of D^T (the transpose of D matrix) onto the eigenvectors matrix G in order to obtain matrix B which contains the EOF's ($B = D^TG$). The reconstruction of the initial data matrix is now $D = GL^{1/2}K^T$ where $KL^{1/2} = B$.

The formula $D = GL^{1/2}K^T$ is also known as the singular value decomposition of D matrix.

For the seasonal variability studies we used twenty four snapshots (one every fifteen days) of the barotropic streamfunction's fields yielded from the perpetual year run of the model whereas for the interannual studies we used ninety six monthly snapshots of the eight years interannual run of the model. In both cases the data set was time-centered and each grid point was weighted by its temporal standard deviation in order to avoid the spatial patterns associated with the larger eigenvalues being dominated by grid points with high variance. A shapiro filtering scheme was also adopted for the elimination of small spatial scales noise.

In the Western basin and for the seasonal variability studies, the first two modes together explain around 89.7% of the overall variability. The first mode corresponds to a sinusoidal seasonal cycle while the second one which accounts for the 29.1% of the variability corresponds again to a seasonal cycle which is now $\pi/2$ out of phase with respect to the first mode. The spatial patterns connected with these two modes (the horizontal EOF's) reveal important information about the standing and propagating behaviour of this sub-basin. As a matter of speculation, the first EOF could be connected with the standing response while the second with the propagating response of the sub-basin to the time dependent forcing.

In the Eastern sub-basin the situation changes compared with that in the Western part a fact which supports our selection to treat them separetely which was based on our preconsumption that they are loosely coupled. The EOF analysis yields in this case that we need the first three EOF's in order to explain the 87.8% of the overall variability. The first mode (the one associated with the largest eigenvalue) corresponds to a seasonal cycle with some small asymmetry embedded on it and explains the 47.8% of the variability. The spatial patterns associated with it probably correspond to the standing response of the basin. The inspection of the horizontal spatial patterns associated with the second EOF points out the existance of small spatial scales and areas which change sign around their temporal average out of phase between each other. This kind of multipolar structure could be indicative of a dynamical system where wave propagation can take place. The second EOF explains 25.8% of the variability and corresponds to a seasonal cycle with a phase shift of $\pi/2$ with respect to the first one.

Study of Levantine intermediate water formation processes, production rates and sensitivity to interannual variability with a 1-D mixed layer model

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A one dimensional modified Kraus-Turner mixed-layer model is used, to study the winter formation of the Levantine Intermediate Waters (LIW) in the Eastern Mediterranean. To force the model we use climatological heat fluxes and wind stress data (P. MAY, 1982 and 1983). The study is carried out in two stages: a) first we apply the model in the whole Levantine Basin and initialize it with climatological T and S profiles (DAVIS *et al.*, 1986). We define the LIW production zone and rate as well as its sensitivity to interannual variability of the heat fluxes. b) we then apply the model to a section of insitu POEM-2 cruise data (POEM GROUP, 1992), and identify the formation mechanism on a finer scale.

Climatological results

1.- **LIW formation area and production rate.**

The model is integrated for two years at each grid point of the Levantine Basin (185 grid points), and initialized with fall (November) climatological profiles. We use an exponential advection term, with a depth scale of 35m, to compensate for the non-zero heat and water budget at each location. An objective map of March mixed layer densities, produced by the model, is presented in figure 1. Densities within the range 28.85-29.10, generally accepted as typical of LIW, are concentrated in the broader area of the Northwestern Levantine during February and March. This area is occupied permanently by the Rhodes Cyclonic Gyre. The mean climatological production rate of LIW is calculated to be equal to 0.99 Sv, a value close to the 1.23 Sv suggested by OVCHINNIKOV (1983).

2.- **Sensitivity study to heat fluxes interannual variability.**

We simulate a severe and a mild winter by increasing and decreasing respectively the total winter heat losses by 300 W/m². In the first experiment the production zone of waters denser than 28.85 was significantly expanded. The LIW production rate was increased to 1.63 Sv while in the central part of the Rhodes Gyre 2.67 Sv of denser than LIW waters were produced with characteristics close to those of the deeper layers. In the second experiment no LIW was produced inside the basin. These experiments indicate a significant sensitivity of the LIW production area and rate to interannual variability.

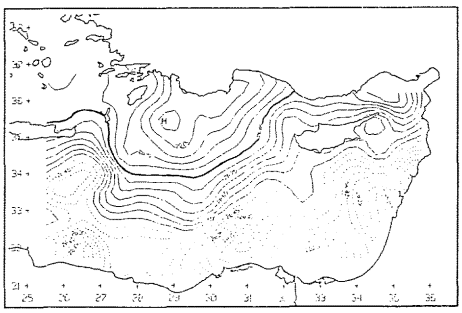

Figure 1

POEM-2 Results

The climatological study suggests LIW is produced inside the Rhodes Gyre area at the end of winter. We further investigate into the details of the production mechanism with the use of insitu POEM-2 cruise data. We use a meridional section of 8 stations running northward from the center of the Rhodes Gyre to the Asia Minor Current. The observations were taken from 27 March to 3 April 1986. The results of this experiment (figure 2), indicate that LIW is formed in the mixed-layer of the central part of the Rhodes Gyre, while at the periphery, a warmer and ligther winter mixed-layer overtops the LIW water mass which we assume has sunk isopycnally there.

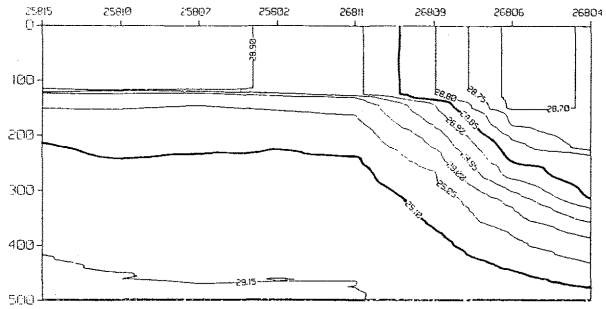

Figure 2

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Volume flux measurements in the Bosphorus using an acoustic doppler current profiler

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The exchange of waters between the Black and the Mediterranean Seas takes place through the Strait of Bosphorus. The inflow to the Black Sea through the lower layer has been found to occur essentially on a continuous basis through the year (LATIF *et al.*, 1991), and based on long-term salinity data the volume fluxes have been determined as 612 km^3/yr for the upper layer and 310 km^3/yr for the lower layer (UNLUATA *et al*, 1990). Direct measurements of the flows in the two layers have been carried out utilising an acoustic doppler current profiler (ADCP). The series of measurements, which commenced in April 1991, have indicated that the volume flux in each layer varies in a wide range, both seasonally and in response to the prevailing meteorological conditions at the time of the measurements. High values of the outflow from the Black Sea, corresponding to about 700 km^3/yr, were observed in April and August, while the maximum values of the inflow to the Black Sea, corresponding to about 350 km^3/yr, were observed in October. The lowest discharge values in either layer were between 50-100 km^3/yr. The surface flow velocities in the northern entrance of the Strait are typically about 20-50 cm/s (Fig. 1). The velocities increase towards the south, due to the shallowing of the interface. Particularly high velocities, of about 150-200 cm/s, exist in the consriction region in the southern part of the channel.

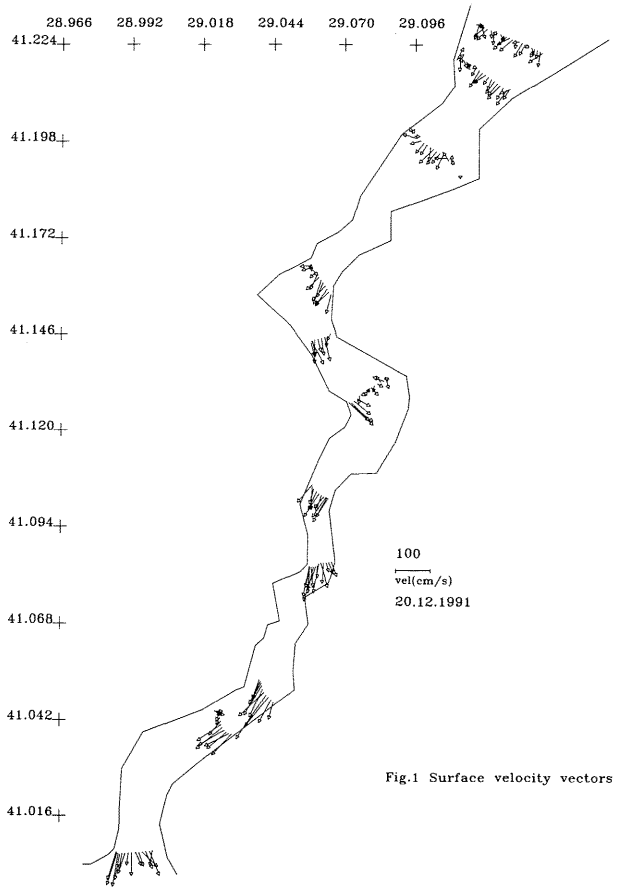

Fig.1 Surface velocity vectors

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Winter Surface Circulation Variability in the Balearic Basin

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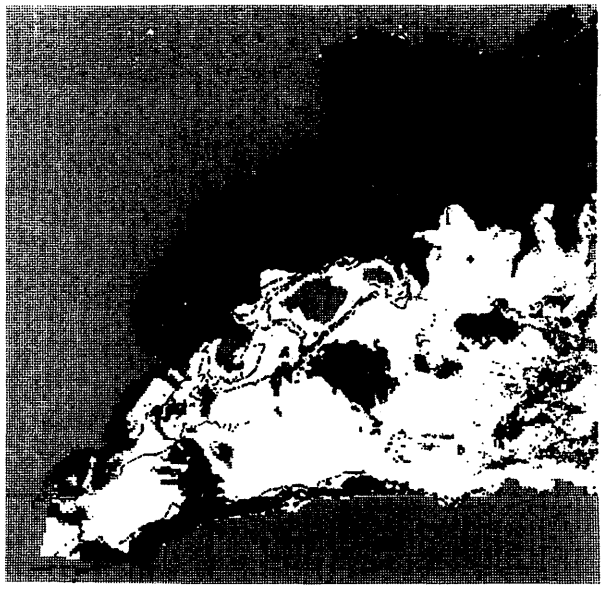

Fig. 1.- sea surface temperature of the Balearic and surrounding basins on 3 February 1990 derived from AVHRR NOAA

During the EEC MAST1 program, the EUROMODEL project has been investigating the processes and forcing mechanisms that drive the circulation in the different regions of the Western Mediterranean. Special attention has been devoted to seasonal variability, the scale of the main driving processes.

The Balearic basin is an area where two different regimes interact: the thermohaline driven circulation of the Liguro-Provençal basin and the large-scale eddy dominated Algerian basin. A series of AVHRR-NOAA images for the autumn-winter period during 1981-1990 has allowed the study of several aspects of the structure and circulation of its upper layer. This study is part of PRIMO, the International Research Programme in the Western Mediterranean.

During the stratified season warm waters occupy the surface mixed layer with a northern boundary delimited by the action of the strong winds in the Gulf of Lyon. This boundary extends to the east, and depicts the most intense surface thermal front observed in the Mediterranean. The progressive erosion of the thermocline allows the observation of the current that follows the continental slope from the north to the Gulf of Valencia. This is the final section of the Liguro-Provenço-Catalan current, the flow that characterises the circulation of the northwestern Mediterranean.

Near the Balearic islands, the irruption through the sills of recent MAW, transported by anticyclonic eddies from the Algerian current, creates the Balearic front and contributes to its mesoscale variability. The latter appears to be much more intense than previously described. Figure 1, a typical winter image, shows this front being continued to the east by the well known North-Balearic front, the feature that usually delimits the northern extension of recent Modified Atlantic Water.

This study was funded by EEC contract MAST-0043-C and CICYT project MAR89-0550. Economic support for travel and exchange was provided by a CNRS-CSIC cooperative project and the Conselleria de Cultura de la Generalitat Valenciana. CETIIS helped in image processing.

O

Water masses dynamics through the Ibiza Channel

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Two oceanographic surveys were carried out at the Ibiza Channel (Balearic Island) during fall of 1990 and winter 1991. A grid of fifty four hydrographic stations placed five miles apart was established. In addition to these (surveys) a single mooring with six current meters was deployed in the center of the channel, during two consecutive periods covering from 15/11/90 to 24/7/91. Six different depths 100, 120, 170, 270, 470 and 720 meters were sampled.

Four water masses were found: Modificated North Atlantic Water (MNAW) at the surface layer (0-200 m), Levantine Intermediate Water (LIW) between 250 and 700 m depth, West Mediterranean Deep Water (WMDW) around 700 m depth to the bottom, and a stational West Mediterranean Winter Intermediate Water (WMWIW) between surface layer and LIW was observed on March.

Hydrographic measurements and dynamic topographies showed two different situations in the superficial waters (Fig. 1, 2): During November 1990 a cyclonic gyre was originated by the superficial movement of a NAW inflow (northward) near Ibiza island and the outflow of MNAW (southward) on the Mainland shore. In march 1991, cyclonic and anticyclonic gyres appeared in the NE-SW axes of the work area. These seemed as an intermediate situation, two bodies of water struggling to flow in opposite directions. Below, these superficial layer, water principally flows southward.

Both North Atlantic and Levantine Waters play an important role in the water exchanges through the Ibiza Channel and both help to cause an upwelling of deep waters on the Ibiza slope. Water masses flow and their stational variability were studied and calculated.

Moreover, time series of different parameters from half hour current meter records are been analysed. Geostrophic velocity distributions across different sections agree with the average velocities recorded by the more superficial current meters (Fig. 3, 4).

Low frequency analysis of this series show a baroclinic situation preferently at the beginning of 1991 and the pass to barotropic conditions on April 1991. From March to May a net southward flow was observed, an important result is the finding of a northward flow in all the column of water from May to July, when the data series recording ended.

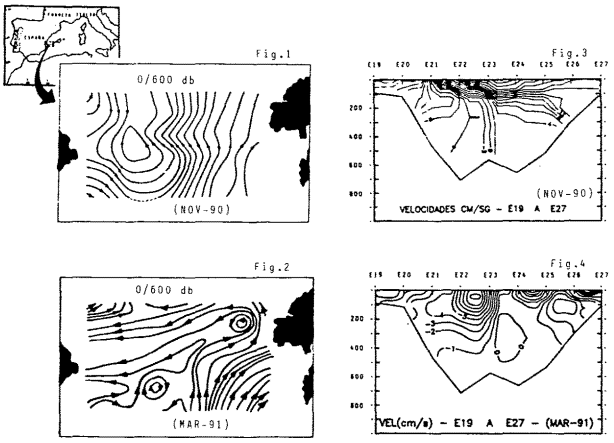

Fig. 1, 2.- Dynamic topographies (dyn cm) of the Odb surface relative to 600 db.
Fig. 3, 4.- Geostrophic velocities in a section on the channel sill.

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Heat storage in the Eastern Mediterranean

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The heat storage in the oceanic surface layers may be subjected to a considerable variability in space and time. In spite of the fact that the heat budget plays an essential role in the dynamics of the Ocean, only few works have regarded the heat storage in the Mediterranean (SAID, 1985 and PICCO, 1990).

The hydrographic data used retrieved from the WDC-A. It is made of about 1300 objectively tested TS profiles for the Eastern Mediterranean selected with a resolution of 0.5° square to obtain monthly mean profiles. Vertical resolution is that of standard depths. The heat storage were considered for the upper 100 and 300 m layers for the Eastern Mediterranean Sea east of Meridian, 20°E. Monthly heat storage (H) in J/m^2 has been estimated using the following relation :

$$H = 1/8 \sum (C_{Pi} + C_{Pi+1})(\rho_i + \rho_{i+1})(T_i + T_{i+1})(Z_{i+1} - Z_i)$$

where:
Cpi: specific heat capacity in J/kg. °k (KorN, 1972),
ρ_i: water density,
T_i: water temperature,
Z_i: level depth,
Subscript (i) is refer to the ith level.

The first layer includes the Mediterranean surface and Atlantic subsurface water masses. The upper 300 m layer contain the upper part or the Intermediate layer as well.

The monthly mean values of heat storage in both considered layers are higher in the Levantine basin than that in the Ionian and Aegian Seas (Fig. 1), due to the fact that the Levantine basin lies in a considerable lower latitude than the other two basins. Moreover, the vertical mixing in the Levantine basin, especially in its northern part, is more effective and may reach to more than 300 m depth. In these regions, the heat gained at the surface reaches to a considerable depths and then horizontally advected westward.

The amplitude of annual signal is greater with about 6% in 0-100 m layer than in 0-300 m in Levantine Sea, and with about 12% and 25% in 0-300 m layer than in 0-100 m layer for Ionian and Aegian Seas respectively.

Heat storage in the upper 100 m layer ranges from about 6.6 E9 J/m^2 in January to 8.7 E9 J/m^2 in October in Levantine basin. In the Ionian Sea, it ranges between 6.3 and 8.1 E9 J/m^2 in January and September respectively. It changes between 6.2 and 7.9 E9 J/m^2 in April and September in the Aegian Sea.

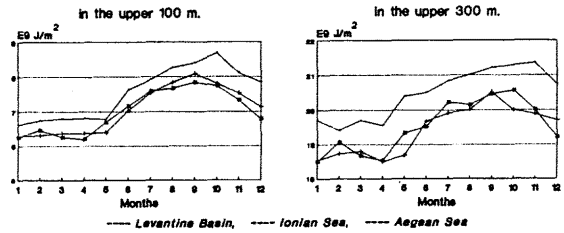

Fig. 1.- Monthly heat storage

In the upper 300 m layer, the heat storage ranges between 19.4 E9 J/m^2 in February and 21.4 E9 J/m^2 in November in the Levantine basin. In the Ionian sea it varies from 18.5 E9 J/m^2 in April to 20.5 E9 J/m^2 in September. In the Aegian Sea, it changes between 18.5 E9 J/m^2 in April to 20.6 E9 J/m^2 in October.

In general, the heat storage is higher and the period of heat storing is longer in the Levantine basin (Fig. 1).

According to the geographic distribution of the amplitude of annual signal, the minimum value, for both two layers under consideration, was observed in the northern Levantine basin while the higher values were found in the south SE of the same basin.

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Hydrography and circulation of the Ionian Sea (1988-1991)

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CTD data collected during the POEM cruises carried out from 1988 to 1991 were submitted to objective analysis for an optimal estimation of the Ionian Sea hydrography and circulation. The distribution of the main water masses in the area (Atlantic Water, Levantine Intermediate Water and Adriatic Deep Water) was examined in relation to the sub-basin circulation features and to different seasons. Horizontal and vertical structure of the analysed fields has revealed a population of anticyclonic and cyclonic eddies interconnected by meandering jets and currents in the upper thermocline. Dynamic processes were generally weaker in the lower layers. Significant variabilities in the principal modes of circulation were however evidenced and are here discussed.

Numerical modelling of the Mesoscale activity and the deep mean flow generation in the Algerian Current

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Algerian eddies are of primary importance to the circulation of all the water masses in the western Mediterranean. Analytical models suitable for stability analysis show the primary importance of baroclinic instability of the Algerian current in determining the caracteristic of these eddies. A numerical modelling of the generation of an eddy is presented using the LODYC 3DPE model in a periodic channel.

Using the same numerical model, these eddies are shown to generate a deep mean flow. The flow appears as a system of two meandering jets: a jet flowing westward near the coast and an offshore jet flowing eastward, both having an enhanced barotropic componant. It is shown that this system is barotropically unstable at longer wavelength than the most baroclinically unstable wave of the initial instability. This instability process generates an eastward coastal surface and deep mean flow. In most cases, during this reversing of two jets system, the surface coastal anticyclones split, creating anticyclones offshore.

Cascade of energy toward larger scale is shown to be a process able to generate larger anticyclones offshore, through successive merging of small coastal anticyclones or small offshore anticyclones previously generated by splitting. This cascade is inhibited by the planetary vorticity gradient. Nevertheless, in this case, large anticyclones are directily created offshore by the meandering of the new mean flow generated at the coast after the barotropic instability.

The introduction of a schematic summer thermocline lowers the available potential of the system: the flow in unstable at smaller wavelengths and the surface and deep mean flow created are much weaker. Nevertheless, offshore anticyclones are still generated through similar processes.

Accurate comparisons with in-situ measurements and remote sensed images, prove that these processes account for most of the observed caracteristics of the circulation in the Algerian Basin.

O

Abnormal surge conditions at Alexandria (Egypt)

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The term "surge" is considered as describing phenomena which are normally attributed to air pressure changes and local wind stress acting on the water near the coast. Therefore, surge heights are determinated by subtracting the predicted tidal heights from the observed heigh of sea level taken from the tide gauge located in the inner part of Western harbour of Alexandria.

The main objective of this paper is to study the highest and lowest surges which are important factors in the design and construction of harbour and other coastal installations.

On the basis of 10 years observational period (1974-1983) of sea level, it can be concluded that mean sea level for Alexandria is 45,5 cm above the zero of the tide gauge. The monthly mean value are below their average during the first half of the year and the rise above their average in the second part of the year (table 1).

Table 1
Monthly average of Sea Level for the period (1974-1983)

Month	J	F	M	A	M	J	J	A	S	O	N	D
S.L cm.	43.9	43.2	37.1	37.7	38.2	46.5	54.7	53.8	48.3	47.7	47.5	51.2

The statistical method made by LENNON (1963) was applied for the hourly surge heights at Alexandria for the period (1974-1983). In this method, the logarithmic scale was used for the average number of cases per year (n/N), where (n) is the number of surges during the period of records which the surge heights (S) exceeded a given value, (table 2) and N= 10 years.

Table 2
The average number of hours during which a positive and a negative surges has been reached or passed for the period (1974-1983)

Positive Surge cm.	Average n/N	Negative Surge cm.	Average n/N
0	4127.6	-5	4040.2
5	2858.2	-10	2763.5
10	1681.3	-15	1594.6
15	775.8	-20	717.2
20	289.6	-25	239.9
25	93.8	-30	69.4
30	29.5	-35	15.4
35	8.5	-40	1.7
40	4.0	-45	0.4
45	1.3	-50	0

As a result of the above mentioned method, two empirical relations have been derived for the frequency of occurence of both positive and negative surges and the surge value were obtained for Alexandria harbour that,

$$\text{Log } (n/N) = -0.082\,S + 3.92 \text{ for the positive surges, after MOURSY (1989)}$$

and

$$\text{Log } (n/N) = 0.102\,S + 4.60 \text{ for negative surges}$$

The linear presentation of the frequencies of both positive and negative surges with the surge height value are shown by Figures 1, 2.

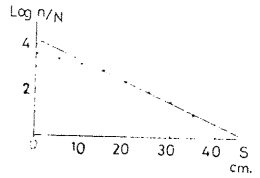

Fig. 1
Relation between the frequency of occurence of positive surge and surge value

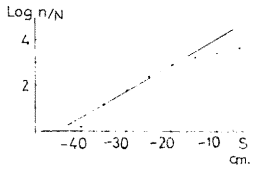

Fig. 2
Relation between the frequency of occurence of negative surge and surge value

On the basis of the above two equations for Alexandria, the positive and negative surges contribution to be exceeded once in 100, 50, 25, 10, 5, 2 years are given in Table 3.

Table 3
The frequency of occurence of positive and negative surges

Number of years	100	50	25	10	5	2
Positive surges cm.	72.2	68.5	64.8	60.0	56.3	51.5
Negative surges cm.	-64.7	-61.7	-58.8	-54.9	-51.9	-48.0

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Upwelling in the North Tyrrhenian Sea: some physical and chemical characteristics

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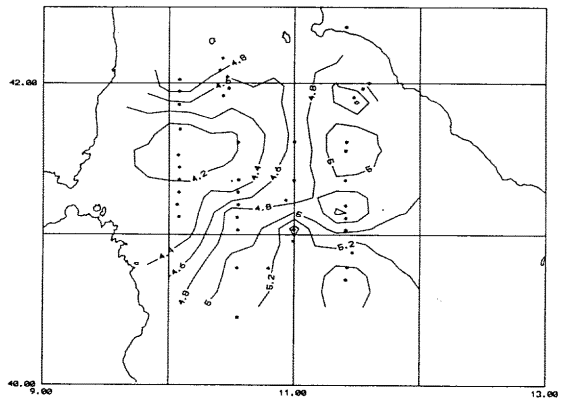
Nearly all studies (i.e. HOPKINS, 1988) pertaining to the Tyrrhenian sea show that this area is characterized by upward and downward fluxes between Modified Atlantic Water, Levantine Intermediate Water and Deep Water. BETHOUX (1981) in his estimate of the potential fertility of the Tyrrhenian Sea attributes about 2/3 of its primary production to the effect of vertical fluxes on the availibility of nutrients to phytoplankton. Additionally, these processes exhibit a large spatial variability due to the peculiar features of the circulation which is characterized by many cyclonic and anticyclonic vortices. The main forcing mechanism is the wind stress curl. The associated Ekman pumping, together with the inflow/outflow at the openings, seems to drive the circulation of the whole basin (ASTRALDI *et al.*, 1991). In particular, while the central area of the southern part of the basin appears very stable, a well developed upwelling is present in the northern part (MOEN, 1984).

The present study attempts to provide a description of the characteristics of the water masses of the North Tyrrhenian Sea utilizing not only their physical but also their chemical properties. Our data, obtained in the late summer of 1989 and in the winter of 1990, indicate, on the basis of temperature, salinity, oxygen and nutrient measurements, the persistence of a zone of upwelling during both periods. This is also seen in the Levantine Intermediate Water, whose core, observed usually below 500m, was found here at a depth lesser than 400m. The upper layer of this zone is characterized by relatively lower temperatures and oxygen concentrations (Figure) and by higher salinities and nutrients.

The structure is also evident in the distribution of nitrates and phosphates. In summer, it is possible to distinguish two areas where these nutrients occupy distinct ranges of concentration, though phosphates exhibit this spatial differentiation in a much weaker manner. The behaviour of these parameters during this period point to the presence of a well developed front that is less visible in winter.

During winter, there seems to be a marked overlapping of the observed ranges for both parameters in the two areas which may be induced by the more uniform vertical fluxes associated with winter mixing. Phosphates show much higher values in winter and the N:P ratio is therefore affected more by the behaviour of phosphorous than by that of nitrogen. This may be due to the influx of the settling products of phosphate remineralization in winter and the greater degree of mixing during this period. The enrichment of the euphotic zone through this vertical upward flux would augment the existing nutrient resources supporting probably a much higher primary production than would exist in the absence of these physical processes.



Oxygen (ml/l) at 100 m depth (Winter 1990)

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Modelling the general circulation of the Aegean Sea
Part I: Wind Forcing Experiments

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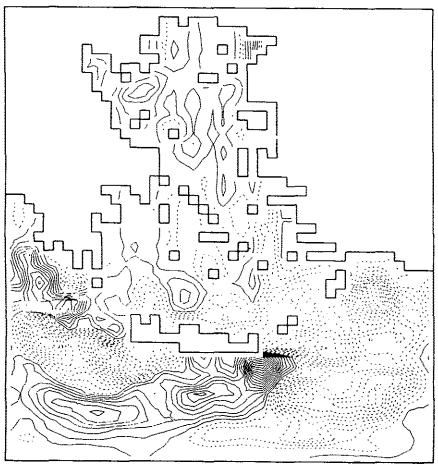
The Princeton Ocean Model (POM) is used to study the wind induced general circulation of the Aegean Sea. POM is a free-surface sigma-coordinates 3-D primitive equation model (BLUMBERG & MELLOR, 1987) designed to simulate both coastal and open sea dynamics. Depth integrated and 3-D equations are solved with different time step using a time splitting technique. The model includes the MELLOR-YAMADA 2.5 turbulence closure scheme (MELLOR & YAMADA, 1982) to calculated vertical heat and momentum diffusivities while the Smagorinsky formula is used for horizontal diffusivities. The model grid covers the area 21°-30° E and 33°-41°10' N with a spacing of 1/6th of a degree in cartesian coordinates and the topography used has been smoothed by an 8th order Shapiro filter. The vertical resolution is 16 levels with logarithmic distribution near the surface. The Levitus hydrological data interpolated in the model grid and mapped into sigma coordinates have been used as initial conditions. The model is forced by monthly climatological wind stress data (HELLERMAN & ROSENSTEIN, 1983). On the open boundary points an upstream advection equation is used for temperature and salinity with boundary values of T and S held fixed to the climatological profiles. At the surface, temperature and salinity are also held fixed to climatology.

In figure 1 the annual mean barotropic transport streamfunction after 5 years of integration is presented. Although a perfectly repeated seasonal cycle is observed in the kinetic energy of the model, almost all the general circulation features maintain their structure throughout the year with seasonal variations only in velocity magnitudes. This absence of strong seasonal variability is concurrent with the almost steady wind field pattern provided by the climatological data. Barotropic and baroclinic velocities are of the same order with typical values 5-10 cm/sec. A number of well known circulation features can be recognized in figure 1. In the SE part (Rhodes area) a cyclonic circulation with flow parallel to the eastern straits is established. This flow enters the Aegean mainly through the central of the eastern straits and bifurcates towards the central Aegean and the Cretan sea, being similar to the typical winter circulation pattern in the area. South-east of Crete a well formed anticyclone can be observed similar to the so called "Ierapetra Gyre" observed from both hydrological data (ROBINSON *et al.*, 1991) and infrared satellite images. This gyre seems the most energetic feature of the area with maximum velocities of ~30 cm/sec. South-west of Crete a large cyclonic feature also known from the POEM data as Cretan Cyclone is observed. Another strong mesoscale feature is the double anticyclonic gyre SW of the Peloponnesian peninsula. This gyre has been found to be the most intense feature of the summer 1986 general circulation of the Ionian sea (NITTIS *et al.*, 1992) and is known to be a permanent feature of the area. In the Cretan sea, two anticyclonic and two cyclonic gyres are present. In the central Aegean, the flow is northward in the centre and southward along both eastern and western coasts forming a complex system of one cyclone and one anticyclone. In the northern Aegean sea, the prevailing feature is the anticyclonic gyre south of the Athos peninsula.

Wind Forcing Experiment (Year 5)

Barotropic Transport (in Sv)



MIN=-7.37E+00 MAX= 7.47E+00 CI=5.00E-01

Figure 1

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A numerical investigation for the mesoscale structure of the Rim Current along the Southern Black Sea Coast

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Contrary to the traditional view of circulation in the Black Sea, the recent high resolution data provided by satellites and hydrographic surveys suggest the presence of complex eddy-dominated mesoscale circulation, often masking the general circulation field. The cyclonic boundary current encircling the basin exhibits strong meandering with wavelengths of 100-150 km, accompanied with eddies and coherent structures.

Despite the growing number of observational work on the mesoscale variability of the Black Sea circulation, little is yet known quantitatively about the mechanisms ultimately responsible for their generation, evolution and decay. A series of numerical model experiments has been performed to explore the dominant mechanisms which may lead to variability observed in the structure of the Rim Current. Particular attention is given to the flow structure along the southern coast of basin. The flow was represented by the inflow-outflow model in a channel of approximately 1000 km long and 200 km wide extending in the west-east direction along the Turkish coast.

The barotropic response of the flow, investigated by the nonlinear barotropic PE model, shows that the interaction of the Rim Current with the bottom topography may contribute to the flow meandering and lead to a number of topographically-induced quasipermanent coastal eddies. The curvature of the coastline in the western part of the analysis region is found to be responsible for generating cyclonic vorticity which ultimately tends to split the Rim Current into two branches at approximately 34 E longitude; one branch proceeds eastward along the coast, the other one bifurcates cyclonically towards the interior. This result indicates that the well-known dual-dome cyclonic circulation of the Black Sea is controlled by the geometry of the basin.

The multi-layered (three layer in the present application) model further reveals that the mean flow becomes subject to mixed instability; the baroclinic instability being the dominant one. The finite amplitude topographic and coastline irregularities as well as the local wind stress variability trigger the instability mechanisms leading to generation of time dependent intense meandering flow pattern and formation of filaments and pinched-off eddies, being simultaneously advected downstream. The filaments are strong offshore jets elongated cyclonically across the shelf-slope boundary into the interior of the basin and are found to be generated in the regions of strong coastline curvature. Their considerable transport capacity of mass, momentum and biochemical materials between the coastal and nterior waters are evident from the observations.

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Features of the Black Sea general circulation emerging from recent surveys and climatological data

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Analyses of data from three different sets of basin-wide surveys (September 1990, June 1991 and September 1991) and other limited surveys along the Turkish coast (1987-1989) are combined with analyses of the climatological data to describe the Black Sea general circulation. It is shown that above 400 dbar, the main features of the Black Sea circulation generally agree with the traditional schemes of circulation, and appear to be persistent on a seasonal and interannual basis though modified in size, position and intensity.

The most conspicuous feature of the upper layer general circulation is the cylonic meandering current confined essentially to the shelf-slope topography encircling the basin. It has a width of 50-100 km, with current speeds of 100 cm/sec and an average speed of about 25 cm/sec on its main axis. The interior of the Rim Current contains a series of cyclonic mesoscale eddies which occasionally merge into one elongated cell covering the entire basin interior, or become separate from each other by anticyclonic eddies pinched off from the Rim Current. The anticyclonic eddy occupying the southeastern corner of the basin constitutes the most persistent, quasi-permanent feature of the general circulation. Shoreward of the Rim Current is occupied by anticyclonic eddies with typical size of 100 km, generated by topographical irregularities and/or barotropic and baroclinic instability mechanisms. Two of the anticyclonic eddies are located to the northwest of the Bosphorus exit and in the vicinity of the Sakarya Canyon region. Two other anticyclonic eddies observed along the southern coast of the Black Sea are situated on the western and eastern sides of the Cape of Sinop. These coastal eddies are observed consistently in all the hydrographic surveys and in the satellite imagery and reproduced partially by the various numerical modeling studies. Along the northern coast of the Black Sea, the most pronounced quasi-permanent feature is the one observed in the relatively smooth continental slope topography of the Danube Fan, to the west of the Crimean peninsula. Three other anticyclones are found along the Caucasian, Crimean and Bulgarian coasts.

Contrary to the findings of the earlier studies, the recent surveys possess important vertical structure in the Black Sea general circulation. The intermediate-depth circulation between 500 dbar and 1000 dbar pressure levels does not show the Rim Current. The circulation consists of several sub-basin scale gyres.

The anticyclonic coastal eddies, aligned along the coast of the basin, appear to play fundamental role on the ultimate distribution of the Cold Intermediate Water. They are advected and entrapped by these eddies, and are continuously modified throughout the year. They often interact with the interior of the basin through the filaments and transverse jets.

The Mediterranean water intrusion and double diffusive convective mixing processes in the Black Sea

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A description of internal processes of convective - diffusive mixing in the Black Sea is given, based on a number of recent data sets.

The Mediterranean waters entering into the Black Sea are rapidly mixed with cold waters on the continental shelf (LATIF *et al.*, 1991) and sink to intermediate depths (≤ 500m), forming a series of cold intrusions spreading horizontally into the interior (OZSOY *et al.*, 1992a, b). The temperature, salinity, suspended load and some other properties of the intrusions can often be traced back to the source region near the southwestern margin. The intrusions result in a unique mechanism of convection partially supported by the unstable double diffusive regime of the interior. The time-dependent convective motions can lead to significant exchange across the permanent halocline, and may explain some peculiarities of the Black Sea interior stratification.

Continental shelf dynamics and coherent structures of the Black Sea circulation locally modify the transport by the intrusions. The interaction of cyclonic boundary currents with the abrupt topography of Sakarya Canyon, and instabilities of the boundary currents motivate cross-shelf transport of the shelf sediments via intrusions and filaments.

Geothermal heat fluxes acting on an otherwise tranquil deep water mass drive a bottom convective layer (OZSOY *et al.*, 1992a, MURRAY *et al.*, 1991). Laboratory experiments and available theory are far from explaining its evolution, but the time of origin of the convective layer is inferred to be of the same age as the formation of bottom waters. The absolute homogeneity of the properties of this layer everywhere in the Black Sea suggests efficient mixing by turbulent eddies. The characteristic time scale of overturning implies a homogenisation period of at least several hundreds of years, required for the entire basin. This may explain the observed continuity of bottom sediment layers within the basin.

The transports between the bottom and the upper layer waters appear to be determined by a diffusive interface at the top of the convective layer, and double diffusion in the water column. A peculiar thermostad separates the pycnocline region from the deep waters. Anomalous temperature fine structure can be observed at all depths in the water column, and appears to be larger near the basin lateral boundaries.

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A central Tyrrhenian Coastal Area as a dynamical test site

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The central Tyrrhenian coastal area extending from the gulf of Naples to the gulf of Gaeta up to Capo Circeo faces a highly urbanized zone, receives industrial pollutant discharges and the runoff of important rivers and includes a variety of coastal and bathymetric features. For these reasons such an area appears to be an ideal test site for coastal dynamical and diffusion studies.

In 1987, on the occasion of the "European Year of the Environment" a Sea Truth operation was carried out in this area, which was surveyed by the LANDSAT satellite, and led to the acquisition of chemical, physical (DE MAIO *et al.*, 1988, 1992) and biological parameters by means of in situ samples taken by ships. More recently, in 1991 two oceanographic cruises were devoted to CTD and direct surface current measurements. As a result a coherent vision of the local hydrology and dynamics has been obtained whose main characteristics will be briefly presented below (they refer to a typical autumn situation).

A homogeneous upper layer of water 20-70 m thick is present, with a temperature of 17.8-18°C (decreasing down to 14°C) and a salinity of 37.80, in which vast regions of less saline water (34-32) due to the Garigliano and Volturno river runoff are observed. The shape of the thermocline and its link with the Levantine Intermediate Water are indicative of baroclinic motions.

The horizontal σt distribution in the upper layer shows clearly the transport directed toward the Circeo, between the isles of Ischia and Ventotene. Moreover, the gradual variation between coastal waters ($\sigma t < 27.5$) and Tyrrhenian waters ($\sigma t > 27.5$) is modified by the intrusion of a tongue of dense water in the area between Circeo and Gaeta. Between Ischia and the mouth of Volturno a lens of denser water with $\sigma t > 27.5$ reveals a dynamic dependence on exterior waters. On the other hand the gulf of Naples appears isolated with respect to this situation, in that it contains less dense waters, especially in its innermost part.

Dynamic calculations based on the hydrological data are in good agreement with the surface currents measured from ship. The northward flow along Ischia and Ventotene turns abruptly to anticyclonic rotation in correspondence to the sill between Ponza and Gaeta, which in fact produces anticyclonic relative vorticity according to the conservation of potential vorticity. More south, NW of the island of Ischia a slow gyral motion is observed. It appears related to the dynamics of the gulf of Naples with which the area is connected through the channels of Ischia and Procida.

Numerical studies based on a sea-breeze model (DALU and PURINI, 1981) and on the shallow water equations for a one-layer and a multi-layer ocean are under way, aimed at reaching a deep understanding of the local dynamics and its dependence on local forcings and on the larger scale circulation. The advectiondiffusion equation is also being used for modelling the intrusion of fresh waters from the rivers runoff.

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Liquid and sediment inputs of the Danube River into the North-Western Black Sea

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Black sea represents an ecological system whose evolution is impossible to be understood all the less prognosticated without a complex, multidisciplinary research, systematically and homogenously accomplished by all riparian countries in cooperation or at least in a permanent exchange of informations. Unfortunately, up to now these desiderata have not fulfilled, the performed research having rather a local character and marked specificity. Thus, at present it has been ascertained the existence of a heterogenous data fund both as measurement methodology and as systematisation style or as processing level of the measurements for almost any discussed parameter.

For these reasons an analyse in the knowledge level of the Black Sea in all respects appears to be necessary, the knowledge of its liquid and sediment inputs being one of the most important. Since the highest quantity of river water which flows into the Black Sea there is in the North-Western part - 81%, the Danube being responsable for about 64% from the total supply (about 200 km^3/year), in the present paper a concise review on the quantitative and qualitative estimations concerning the liquid and sediment inputs of the Danube River will be made. In order to prepare this synthesis it was used the results obtained by the scientific staffs from the National Institute of Meteorology and Hydrology - which carried out the synthetic measurements of the liquid discharge of the Danube and its main tributaries on the Romanian territory; Institute of Geology and Geophysics - the producer of the synthetic studies concerning the solid discharge of the Danube and the evolution of the deltaic and the Romanian nearshore zones; Romanian Institute for Marine Research - the author of systematic studies regarding the quality of the Black Sea waters on the Romanian shelf and the evolution of ecological system constituted by these.

The first part of the paper refers to the liquid input of the Danube. It first chapter presents the informations regarding the liquid discharge of the Danube into the sea : the multiannual mean values for various periods (the longest one being 1858-1988); the extreme values of the variation range and the multiannual monthly means. A comparison between the evolutions of annual means of Danube discharge at the inlet into the Danube Delta and at the outlet into the Black Sea is made.

The second chapter refers to the chemical characterize of the Danube Waters. Thus, the variation range of the main chemical parameters of the Danube waters before the building of the Iron Gates dams (1970) is presented. Then, a review of the annual means of the major chemical parameters after 1970, for various points of the Danube route along the Romanian territory simultaneously and at the outlet into the Black Sea make evident the progressive increase of the total ionic content. After that, a comparison between the ionic and liquid annual discharges, before and after 1970, for the nitrogen, phosphorus and silicon ions, is given. Further on, a comparative table of percentage content of main ions for the Danube waters at the outlet into the sea and that of the sea waters in the same zone is presented. Finnaly, there are the values of the main statistical parameters characterizing the major chemical constituents own of the marine coastal waters at Constantza, evolving the pollution indices of them.

In the framework of the second part of this paper, the solid input of the Danube is discussed. Its first chapter include the informations concerning the solid discharge of sediments : the multiannual mean values, the extremes of variation domain and the percentage repartition of the sediments transported among the three branches of Danube. A comparison between the situation existing anterior the building of the Iron Gates dams and the subsequent one is given.

Also, a comparison between the evolution of the annual mean values of the solid discharge at the inlet into Delta and at the outlet into the sea is describe.

The second chapter has in view the chemical, mineralogical and textural characteristics of bed and suspended load of the Danube at the outlet into the Black Sea. The mean values and the variation domains of the main chemical parameters of the sediments as well as the percentage mineralogical composition are presented, pointing out the heavy minerals. Afterwards, the granulometric characteristics of the major lithologics types in the transported sediments both on the main Danube branches and on the canals are evinced.

The third part of the paper refers to the Danube solid and liquid inputs on the marine deltaic zone and on the littoral morphodynamics. Thus, recent research (1990 and 1991), spotlighting Danube as the main pollutant agent of the marine environment in the North-Western shelf, where the majority of the trace elements appear in higher concentrations compared with those of older preindustrial sediments, are presented. Further on, the modifications of deltaic zone configuration are discussed and a few littoral morphodynamic processes which are going under the obvious influence of Danube sediment input are enumerated : the general trend of progradation of the Danube Delta; the modifications of the Delta front slope and of sea bottom and inshore zone configuration.

In the last part of the paper, there are presented the recent direct measurements of the liquid and solid discharges in the various sections of the Sf. Gheorghe branch. Also, there are enumerated the critical problems and the major desiderata concerning the research of the ecologic system constituted by the Danube River, Danube Delta and the North-Western part of the Black Sea.

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ALMOFRONT 91 : An interdisciplinary study of the geostrophic frontal jet in the Eastern Alboran Sea

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The ALMOFRONT-91 cruise of R. V. L'Atalante, during May 1991, was devoted to study the geostrophic front which lies between Almeria (Spain) and Oran (Algeria) in the eastern part of the Alboran Sea. The oceanic density front was found on the left side of the geostrophic jet which constitutes the atlantic water inflow into the Mediterranean. The main objectives which guided the strategy at sea were:

1/ to master the physical and dynamical parameters at a resolution that allows the calculation of vorticity and secondary (ageostrophic) circulation.

2/ to characterize the primary and secondary levels of the ecosystem in terms of stocks, production, growth rate, physiological stage or maturity .

3/ to evaluate the fluxes of matter in the frontal zone and the exports.

As revealed from the 83 CTD-rosette stations survey at synoptic scale (Fig. 1), the Atlantic jet was flowing along the Algerian coast with a 100 m thick, strong, horizontal density gradient and enhanced biomass along the flow (Fig.2). Phytoplankton composition as viewed by pigment analysis evidenced a strong upward supply of nutrients in the frontal zone. This upward flux was attributed to the secondary, ageostrophic circulation. The internal structure of the mass and velocity field was investigated by 4 CTD Tow-yo and ADCP sections through the main flow. A towed hydro-electric system (THES) which measured physical, biological and chemical variables by underwater probes and on pumped water, was operated between surface and 200m depth. This was repeated on three sections (Fig. 1) in order to reveal the nutrients, oxygen, biomass and pC02 fields as perturbated by the frontal zone. Subduction of dense water which is near surface north of the front below the light water of the jet is clearly signed, by anomalous vertical profiles of these chemical and biological variables.

A second, 15-day long leg was devoted to fluxes measurements in 6 sites representative of the frontal structure. The export of organic matter inside the frontal zone towards deep water is dramatically marked by the amount of matter found in drifting sediment traps. An subduction of water is also inferred from results obtained in 1990 inside a meander of the Ligurian Sea jet where mass and velocity fields are similar to those encountered in the Alboran sea jet.

The presentation corresponds to an overview of main results on the biophysical aspects of this study of which more 50 scientists participated.

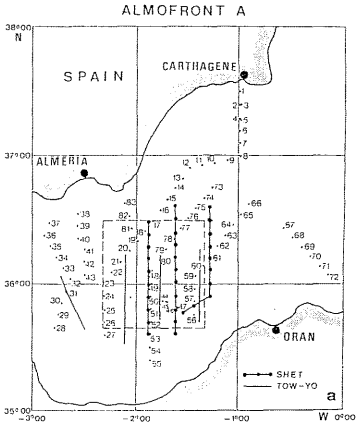

Fig. 1.- Map of Almofront stations and Tow-yo transects for Leg A, April 26 - May 12, 1992. Dots with numbers indicate the position of the 83 CTD casts of the synoptic survey. The four lines correspond to the 4 Tow-yo transects across the frontal jet structure. Dots linked by thick line indicate the 31 THES stations.

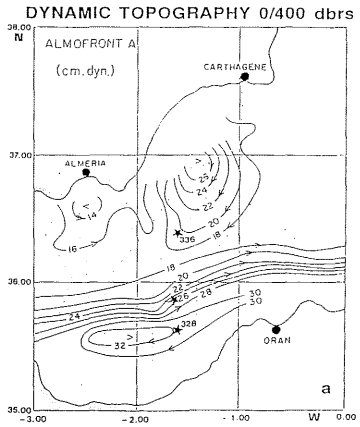

Fig. 2.- Results from the 83 stations of synoptic survey: Dynamic topography of the surface level relative to the 400 dbars level. The south position of the jet and two eddies at north are clearly shown. The stars indicate the positions of the 3 THES stations which will presented to evidence the subduction of the water, North of the jet front, southward and below the core of the jet.

Remote sensing of the generation and propagation of internal waves in the Strait of Gibraltar

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During the international GIBRALTAR EXPERIMENT, in 1985-1986 (KINDER and BRYDEN, 1987), we realized from an aircraft equipped with a Synthetic Aperture Radar, a survey of the strait of Gibraltar, during two semidiurnal tidal cycles (RICHEZ and KERGOMARD, 1990 and RICHEZ, 1992).

The SAR images clearly illustrate the generation and evolution of an internal structure, at the sill of Camarinal, during the westward phase of the tidal cycle. Its relation to a detailed topography of the sill is in agreement with the theoretical work of HIBIYA (1990). When the westward tidal current relaxes, this structure, moving east over the sill crest, transforms into an eastward propagating internal bore. At the same time, a lee-wave appears on the eastern side of the sill of Camarinal, as observed and explained by ARMI and FARMER (1988). It is obvious that the diurnal component of the tide plays a major role in determining the type of nonlinear wave train travelling along the strait and its speed of propagation. Two solitons with the same amplitude propagated at a mean speed of 2.1 to 2.6 m/s, during the first flight, while during the following tidal cycle, a train of dispersive nonlinear internal waves appeared in the Tarifa Narrows and the speed of propagation of the leading wave was about 1.9 m/s.

The ARMI and FARMER (1988) echosounder and mooring in situ observations helped the interpretation of the SAR images, and are quite in agreement with them.

Some images from the french satellite SPOT, taken at different tidal coefficients give an idea of the variability of the occurrence of this phenomenon in the strait of Gibraltar. At neaps, with weak tidal coefficient, we cannot detect any clear generation of internal structure at the sill of Camarinal. At springs, an other solitary wave event can be detected at the eastern end of the strait of Gibraltar, 2H:30 to 4H after the passage of the principal bore. We give a tentative explanation of this feature, already observed by ZIEGENBEIN (1969, 1970).

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Seasonal and interannual variability of the Black Sea circulation Numerical modelling

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Deep and intermediate waters in the Black Sea are strongly influenced by the variability in the Bosphorus an rivers inflow, buoyancy fluxes at the sea surface and the momentum flux. The analysis of meteorological data illustrates their seasonality and the strong interannual signals. The response of the sea to the forcing changes includes variations in the intensity of the general circulation, formation of quasi permanent sub basin gyres and changes in the total heat content in the cold intermediate layer. Major physical problems are the interplay between the large variety of forcing factors, the mechanisms of the formation of vertical stratification and the energetics. The lack of experimental data motivates us to try to understand how the Black Sea works using numerical models with improved forcing. So far the numerical models are forced with climatic annual mean or seasonally varying boundary conditions. Such forcing functions do not include enough variations in the atmospheric signal. Its amplitude is drastically reduced which could result in underestimation of the sea response to the atmospheric signal. In the present work we address the problem of the role of high frequency variability for the ocean circulation on the example of the Black Sea model.

The numerical model used in this study is the well known GFDL Princeton Ocean General Circulation Model (OGCM). Horizontal resolution is $\Delta\lambda = 1/3°$ $\Delta\varnothing = 1/4°$. The vertical structure is approximated using 11 levels with vertical resolution varying from 20 m in the surface layer to 980m in the deepest part of the basin. Bottom relief and coastal line are specified from bathymetric map in the horizontal grid points.

The model is initialized with annual mean temperatures and salinity. Small area including the Strait of Bosphorus is relaxed to the climatology in order to maintain the exchange with the Mediterranean Sea. After the model fields adjust to the initial forcing and topography the integration continues with time variable forcing.

Forcing functions are calculated in the model from the NMC 12 hours atmospheric analysis including air temperature, humidity and winds at the sea surface. Sea surface salinity is relaxed to monthly mean data. All forcing functions are interpolated linearly at each time step. The model is run for 9 years and the analysis of the simulated results is presented in this paper. The emphasis is given to the processes which form the sea surface heat fluxes, intermediate water formation, variability of the circulation patterns and to the net role of the short period atmospheric variability for the general circulation. The comparison of the simulated results obtained for each year manifests the fundamental role of the interannual atmospheric variability for the Black Sea circulation.

Eulerian and Lagrangian statistics of mesoscale motions in the Tyrrhenian Sea

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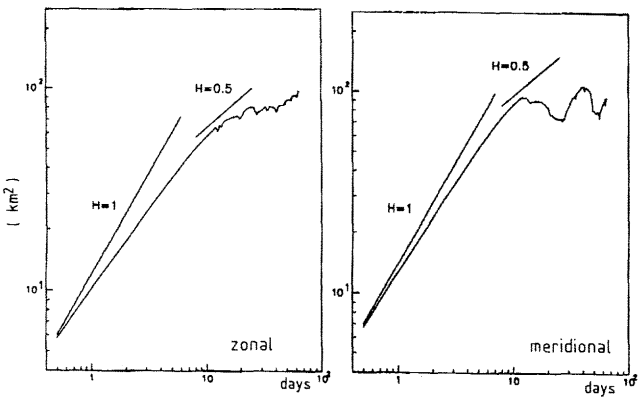
A data set from the three free satellite-tracked drifter buoys (drogued at a depth of ten meters) and the three current-meter moorings deployed in the central Tyrrhenian sea in autumn 1989 during the TEMPO experiment (TEMPO Group, 1990), was analyzed. The circulation in this area is dominated by large and coherent systems of vortex of an estimated scale of about 100-200 Km. Other than the surface dynamical and statistical properties of these vortices, the study focused on relating the Eulerian and Lagrangian description of the flow field on the basis of the drifter data and the data from a current-meter placed at depth of 8 meters.

Both the drifter and current-meter spectra indicate that the characteristic frequencies of the basin (around 20 and 10 days) exhibit a high anticlockwise polarization, which drastically decreases with depth. The autocorrelation functions reach the zero value after about 10 days for both the drifters and the surface current-meter with the relative integral time scales, (T_{Lx}, T_{Ly}) = (2.0, 1.8) days and (T_{Ex}, T_{Ey}) = (2.3, 0.9) days. The substantial equivalence between the Eulerian and the Lagrangian time scale infers weak non-linear (advective) effects for periods extending from 1 to 10 days.

The study of the structure function $S_i(t) = ([X_i(t+\tau) - X_i(\tau)]^2)^{1/2}$ (COLIN de VERDIERE, 1983) showed an anomalous behaviour ($S_i(t) \propto t^H$ with $1/2 < H < 1$) for $1 \leq t \leq 7$~8 days with a scaling exponent of $H \sim 0.8$. For $8 < t <$ ~15 days, a transition, especially on the zonal direction, towards a brownian like motion can be observed (Figure). For greater t the drifters are diffused less than required by a random walk and the motion is dominated by the strong wave like vortex circulation. The analysis of the behaviour of the coefficient of eddy diffusivity with time provided a numerical estimate of (K_x, K_y) = (2.9, 3.5) $\cdot 10^7$ cm^2/sec which was however valid only for $8 < t < 15$ days. For greater t our drifter records are too short to resolve the properties of diffusion of the vortex although a value of $O(10^6)$ cm^2/sec or less for K seems appropriate.

Moreover, the drifter trajectories display a homogeneous fractal behaviour with a dimension D ~1.3, for $1 < t < 7$ days and $10 < L < 80$ Km in the time-space scale of both the eddy dynamics and the anomalous diffusion. A fictitious trajectory obtained by integrating the velocity data of the surface current-meter displayed similar fractal and diffusion characteristics in the same space and time scale. A multifractal analysis of the velocity time series of the same current-meter using the generalized Reny's dimension showed homogeneous behaviour in the eddy time scale and evidence of multifractality or intermittency for $t \leq 4$~5 hours. The spectra of the surface current meter and the freely moving drifters demonstrated a similar shape with the same slope in the range of 1-10 days. The results of our analysis, thus seem to indicate that, in these time scales, the fractal and diffusion characteristics of the drifter trajectories are "driven" by the Eulerian field and are apparently less influenced by nonlinear phenomena like chaotic advection.

On the other hand, a significant difference between the root mean square velocities of the drifters and the surface current-meter (the drifter values were definitively larger) was observed suggesting the relevance of nonlinear effects in high frequency time scales.



A log-log plot of the dispersion versus time

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A Water budget study of the Southeastern Mediterranean off the Egyptian Coast

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Water budget is one of the most important problems with which meteorology and oceanography is concerned. It can be assumed with a very considerable degree of probability that the cycle through which the water passes is closed. For a quantitative assessment of the water budget on the Egyptian Mediterranean coast it is necessary to make estimate of the amount of water circulating through it.

The experimental area (Fig.1) has a surface area of about 154840 km^2 and its water volume of 224801.55 km^3. Striking features of this area are the presence of different water masses which converge and mix. According to the outline of circulation in the Eastern Mediterranean, the incoming flux after passing through the Strait of Sicily follows a cyclonic gyre along the coasts of the Eastern basin. An example of the Egyptian Mediterranean waters circulation pattern was given by GERGES (1981). He used all available surface current measurements collected throughout a period of 50 years, up to the early Seventies, and indicated that the surface currents in the Southeastern Mediterranean are mostly eastward and southward.

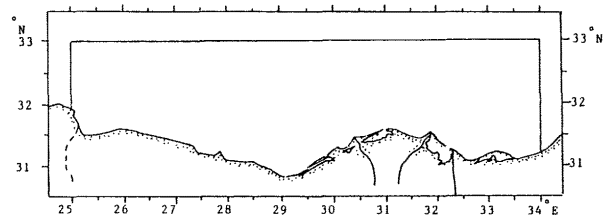
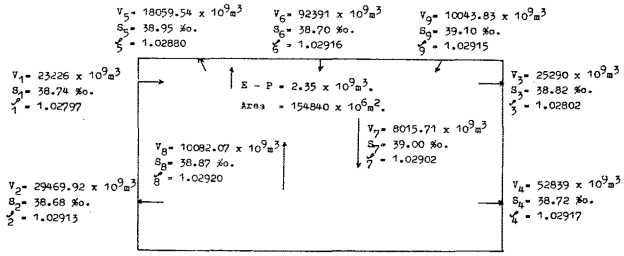


Fig.1. Egyptian Mediterranean Coast.

In the western sector of the experimental area the mean calculated salinity 38.74 ‰ occupies the upper 0-150 m layer. In the eastern sector of the area, according to the results obtained by BETHOUX (1980), the mean surface flux V_3 is about 25290 x 10^{9}m^3 and salinity 38.82 ‰.



Below this level, there exists an intermediate layer of maximum of salinity. The isopycnal analysis of the study area indicated that, the inflowing intermediate water from the Levantine basin (V_9) and the water formed on the Egyptian Mediterranean shelf (V_7) flow away from the continental shelf to the northwest in a high-salinity tongue (V_5) and reaches the open sea with values as low as 38. 95 ‰ . If we suppose as BETHOUX (1980) that the intermediate water conserves its original salinity of 39.10 ‰ up to the Egyptian waters, 39.00 ‰ on the Egyptian shelf and 38.95‰ up to the open sea (SAID and KARAM, 1990).

The horizontal and vertical fluxes, salinities and densities are summed up in diagram 1. Fluxes V_2, V_4, V_6, V_7, V_8 and V_9 and salinities S_2, S_4 and S_8 are initial unknowns and their values are the proposed solutions resulting from the water and salt budgets equations. The deep Eastern Mediterranean waters (V_6) are characterized by 13.60 °C and 38.70 ‰. From the quantitative analysis of the Southeastern Mediterranean waters off the Egyptian coast the mean calculated values of S_2, S_4 and S_8 are 38.68 ‰, 38.72 ‰ and 38.87 ‰ respectively. The mean annual water deficit (evaporation, E-"precipitation + runoff", P) is equal to 2.35 x 10^{9}m^3. The schematic presentation in diagram resumes the annual mean calculated values of the fluxes in the Egyptian Mediterranean coast together with the resulting water deficit.

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Evaporation from the Mediterranean shelf waters off the Egyptian Coast

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Evaporation from the Mediterranean shelf waters off the Egyptian coast was estimated during the period from August 1983 to 1986, using different techniques. The data used were taken from eight cruise, carried out to the Southeastern Mediterranean between longitudes 29° 45'E and 33° 45'E, using RV Noor Ya Nabi. During each cruise, two separate data sets were collected : standard meteorological measurements and hydrographic data, from 26 stations located along eight sections (Fig. 1). In addition, the recorded monthly evaporation data along the Egyptian Mediterranean coast during the period of study were made available through the Egyptian Meteorological Authority-Cairo, Egypt.

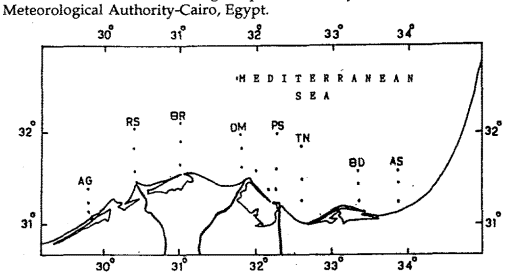

Fig. 1.- Area of investigation.

On the basis of the heat-budget equations, evaporation was computed using Schmidt's ratio R'(1915) and Bowen's ratio R (1926). Also two different forms of the aerodynamic method (SVERDRUP, 1937 and PENMAN, 1956) were used for computing the evaporation. The obtained results were averaged over eight transects and listed in table (1).

The agreement between the observed and calculated values of evaporation by SVERDRUP's formula was good, and considerably better than the cases treated by the other authors. The total evaporation during the year was about 155.6 cm from the observations and 151.5 cm based on SVERDRUP's formula. These values were slightly more than 1450 mm, the mean evaporation for the Mediterranean (SVERDRUP,1942; DAUME,1950; WUST, 1959).

Table (1) Seasonal and annual values of evaporation (cm) from the Egyptian Mediterranean shelf waters using different techniques

year / used method	1983	1984			1985		1986		Annual
	August	February	July	October	April	July	February	July	Evaporation
1. Observations	14.322	11.948	14.353	13.795	12.960	15.624	8.736	14.777	155.60
2. Heat-budget equations using									
a- R' (Schmidt)	16.621	4.225	18.550	6.788	13.978	18.360	4.028	18.492	128.70
b- R (Bowen)	26.200	7.282	32.058	13.864	21.993	27.945	6.618	30.832	216.20
3. Aerodynamic method using :									
a- Sverdrup's formula	14.588	9.379	14.821	12.265	13.375	16.572	9.657	15.338	151.50
b- Penman's formula	20.417	12.765	20.237	17.383	17.951	22.614	13.479	20.788	208.40

The total evaporation from the study area (27,000 km^2) amounts to 42 km^3/year, of which 3.3 km^3 returns to the sea in the form of precipitation and the difference, 38.7 km^3, must be supplied by run-off , since the salinity of the water area remains unchanged. The coastal part of the study area receives about 17 km3/year from the northern Delta lakes, fresh water from the Rosetta Nile Branch as well as large amounts of sewage and industrial wastewater. These amounts represent 37.78 % of the total volume of the coastal waters. Within this area the values of most parameters vary both in time and space, particularly those of salinity.

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Salt fingering processes and the distribution of the density ratio in the Southeastern off the Egyptian Coast

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Temperature and salinity (T-S) finestructure on vertical scales of 10 db and larger is examined in a 215 km by 110 km grid located southeastern Mediterranean off the Egyptian coast. The convergence of several water masses within the grid dominated by the Levantine Intermediate Water leads to a variety of T-S finestructure which unstable to double diffusive processes. The data used in this study were collected during the joint Soviet-Egyptian expedition on the Russian RV Akademic Levrentyev which took place from 20 to 26 December 1988.

Vertical profiles of temperature, salinity, density and density ratio Rp for a number of stations in the experimental area are selected to identify the salt fingering regions. Vertical profiles from a selected station located at the western boundary of the area are shown in Fig.1. A profile of the stability angle Tù taken from Washburn and Käse (1987) defined as :

$$Tù = \tan^{-1} \frac{\alpha Tz - \beta Sz}{\alpha Tz - \beta Sz}$$

where α is the coefficient of thermal expansion (α >O), β the coefficient of haline contraction, and Tz and Sz the vertical in situ temperature and salinity gradients. The vertical distribution of Tù allows portions of the profile to be grouped into four stability regimes : S denotes a stable region of the profile, U a region with density inversions, SF a region diffusively unstable to salt fingering, and DL a region unstable to double diffusive layering.

To quantify the frequency of occurrence of Tù in the various stability regimes, all Tù estimate from all stations were sorted into a histogram which is shown in Fig.2. By forming histograms of the density ratio Rp, a fundamental parameter in controlling double diffusive processes, it is found that 66 % of the volume is unstable to salt fingering while the unstable gradients are found in the 11 % of the profiles. In about 23 % of the volume, Rp is less than 2 in the salt fingering sense and at these low values salt fingers grow rapidly. SCHMITT (1979) has developed a similarity theory which describes the initial growth rates for salt fingers and found that for Rp ≤ 2, salt fingers grow rapidly.

One primary salt fingering region is found from about 300 to 1000 db with a modal Rp of 2.0. A horizontal map of Rp in the salt fingering region showed that the strong horizontal Rp gradients underlie relatively high salinity regions and vica versa.

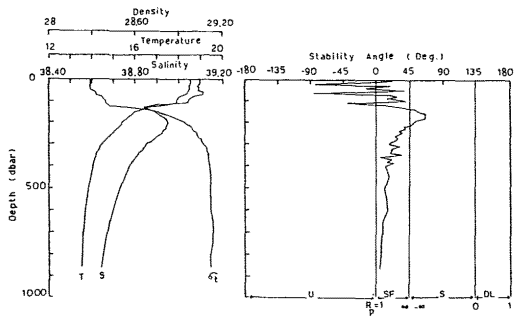

Fig .1.- Profiles of water temperature, salinity and density for station 2056. Profile of the stability angle is shown in panel at right

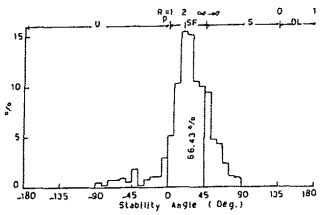

Fig. 2.- Histogram of stability angle from all stations. Stability regions and Rp scale are shown at top of figure.

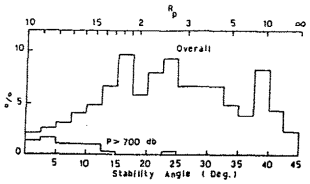

Fig. 3.- Higher resolution histogram of stability angle for salt fingering portion of the histogram of Fig 2.

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Water fluxes induced from the wind stress over the Northern Red Sea and the Gulf of Suez

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The expected controlling factor in driving the circulation of the upper surface layer in the longitudinal direction along the main axis of the Red Sea is the wind stress (GERGES & SOLIMAN, 1987). The variation of the wind stress with time over the northern region of the Red Sea is thought to be one of the main controls on that of the surface transport. Consequently, the aim of the present work is to examine the relationships of the variabilities of the surface flux with those of the wind stress over the northern Red Sea off the Egyptian coast and the Gulf of Suez.

Zonal and meridional components of the wind stress (Fig.1) over the northern Red Sea and the Gulf of Suez were calculated from each station wind observation through the bulk formulas. The data used in this study were collected during the joint Soviet-Egyptian expedition on the RV Professor Bogorov which took place during the period 1-6 March 1990.

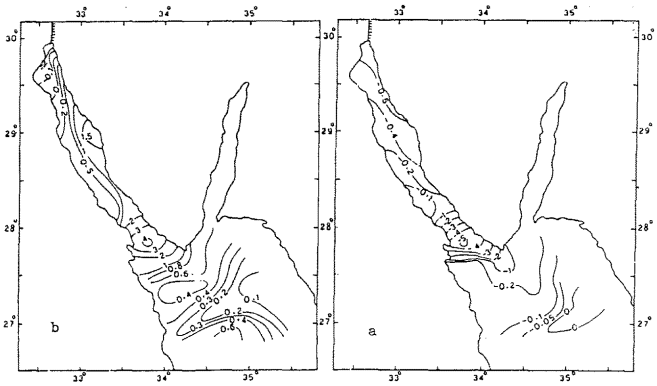

Fig.1. Zonal (a) and meridional (b) components of the wind stress in gm/cm/sec^2.

For the zonal component of the wind stress, the high energy area corresponds to the southern part of the Gulf, where the westward wind stress is dominant and decreases northward and southward. The highest energy area for the meridional stress is found around 27° 30'N and 33° 30'E which is the same position as that for the zonal stress.

Based or the wind stress components, the zonal and meridional components of the Ekman flux for the upper 50m layer (Fig.2) were computed. Zonal fluxes were in the eastward direction. The magnitude of the eastward flux was larger in the Gulf (8.84 m^2.sec^{-1}) than those through the northern region of the Red Sea (7.82 m^2.sec^{-1}). The meridional Ekman fluxes were northward, i.e. against the wind direction. This is in agreement with the Barlow's (1934) results.

Summations of the Ekman fluxes through the southern boundaries of the study area were about 13.13 m^2.sec^{-1}, of them 9.35 m^2.sec^{-1} through the Gulf of Suez.

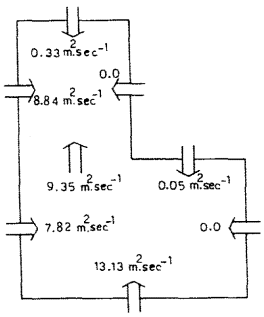

Fig. 2.- Volume fluxes due to the Ekman currents through zonal and meridional boundaries of the study area

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A quantitative Analysis of Southeastern Mediterranean water masses

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The Southeastern Mediterranean was one of the least investigated areas until the last two decades. To date, no one has been determined the volumes of water represented by the various θ-S types on the Egyptian coast. The present study deals with an attempt to identify the important water masses and their limits in the Southeastern Mediterranean off the Egyptian coast using the volumetric analysis technique during winter and summer seasons.

The oceanographic data used were selected from several expeditions carried out by Egypt and different countries during the last 27 years (1959-1986). Water temperature and salinity data have been taken from 162 stations in winter and from 152 stations in summer. The average values of temperature and salinity of these collected data were computed for stations distributed in a grid for winter and summer seasons. The volume and the mean depth of the waters in each bivariate class with potential temperature range 0.2 or 0.5 °C and salinity range of 0.1 ‰ have been estimated during winter and summer. The resulting statistics were presented on a pair of characteristic diagrams, each having potential temperature as ordinate and salinity as abscissa.

On a bivariate distribution, a boundary has been drawn to enclose all classes of a certain frequency (volume) and greater frequencies. Each standard boundary encloses the smallest area that contains at least the standard proportion of occurrences. The 50-per-cent and 75-per cent boundaries were established by the cumulative addition of frequencies in descending order of magnitude (Fig.1).

In winter, the three largest classes at potential temperature range 13.3o-13.8o °C and salinity range 38.70-38.80 ‰ contain nearly 50% of the total geometric volume and comprise the core of the deep water of the Eastern Mediterranean off the Egyptian coast. In summer, as in winter, a primary and big mode appears at a potential temperature 13.40 °C and salinity 38.75 ‰. It occupies the deeper classes below 1000m depth and is called the deep water mass. The 50-per-cent boundary, encloses three classes from the total of 93. This boundary lies between the potential temperature range 13.30-14.00 °C and salinity range 38.70-38.90 ‰. The 75-per-cent boundary encloses six classes in one group. Outside the 75-per-cent boundary, a secondary mode with high salinity (38.95 ‰) and potential temperature (15.25 °C) is observed. This water mass is called the intermediate water mass which is characterized by a secondary maximum of salinity (38.80-39.10 ‰). Its volume is about 18059. 54 km3 and represents about 8. 03% of the total volume of the Egyptian Mediterranean waters. A third mode in bivariate distribution appears at temperature 18.75 °C and salinity 38.75 ‰. This mode forms the subsurface layer of minimum salinity which is of the Atlantic origin.

For the univariate distribution, it was remarkable that the mean potential temperatures and salinities were 14.141 °C and 38.818 ‰ in winter and 14.407 °C and 38.807 ‰ in summer. Temperature and salinity of half of the water volume were below the mean values. The characteristics of temperature and salinity at 5, 25, 50 and 75 % were identical during the two seasons.

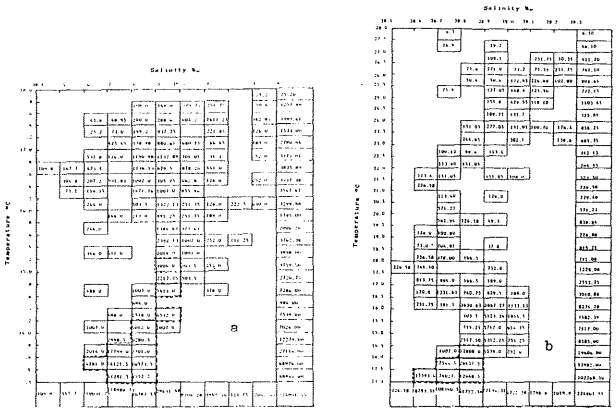

Fig. 1.- Potential temperature-salinity diagram of the Southeastern Mediterranean waters during a- winter and b- summer. Heavy boundary encloses 50 percent of the total and the dotted boundary encloses 75 percent. Volume in km3.

The interaction between the Catalan and Balearic Currents in the Southern Catalan Sea, FE91 Cruise (May 1991)

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The circulation in the Catalan sea is dominated by the Catalan current, a continuation of the Liguro-Provençal current along the continental slope, in geostrophic equilibrium with a typical shelf/slope front (WANG *et al.*, 1988). On the Balearic islands side there is another front which delimites the incursion of southern mediterranean waters with lower salinity of Atlantic origin (SALAT & CRUZADO, 1981). These two main dynamic features interact in the southern half of the Catalan sea (CASTELLON *et al.*, 1991).

The FE91 Cruise was a part of the "Flotadors Errants" series of cruises to contribute to the knowledge of the mesoscale features associated to the circulation in the Western Mediterranean. During May 1991, the southern half of Catalan Sea was covered with a net of CTD casts (Fig. 1), ADCP measurements and TS surface continuous analysis along the ship track, and a synoptic coverage of AXBTs. Samples for organic micropollutants and radioactive tracers were also obtained at several points. In this paper, the main preliminary results concerning circulation are presented, while some of the information is still under elaboration.

Summary of Results

The shelf/slope current suffers two important deflections (Fig. 2): the first at a change of the slope orientaton at 40°30'N 1°40'E, and the other at 39°30'N 1°E. At this point, it the main flow is definitely detached from the slope and a residual flow continues attached towards the Gulf of València to reach the Eivissa channel.

The circulation over the wide shelf between these two points is anticyclonic, dominated by inertial oscillations (SALAT *et al.*, 1992). It plays a role of a trap for the Ebro river discharges (Fig. 2). At the open sea side, in the northern point appears a clear signature of a cyclonic eddy that may deviate, towards open sea, part of the shelf/slope waters and also help the propagation of filaments of shelf water described by WANG *et al.* (1988).

The southern waters of Atlantic origin appear in the upper 100 m at the eastern side of Eivissa channel (Fig. 2) forming a well defined anticyclonic eddy. A remarkable surface front is detected in the northern side of this eddy, when it contacts the deflected Catalan current at 39°30'N. As the southern waters are lighter, the water coming from the north sinks and passes underneath.

The organic micropollutans have two main sources: one in the northern coast (Cap Salou) and the other in the southern coast (out of the map). The maximum concentrations of those compounds are found in two zones: one in the wide northern shelf, accumulated by the anicyclonic circulation there, and the other associated with the entrance of southern waters.

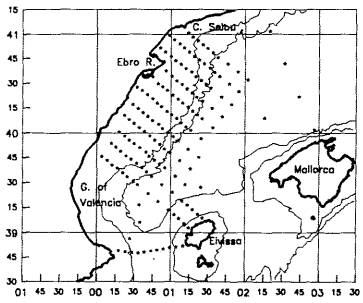

Fig. 1. Map of the studied region showing the CTD stations and bottom topography (200 and 1000 m)

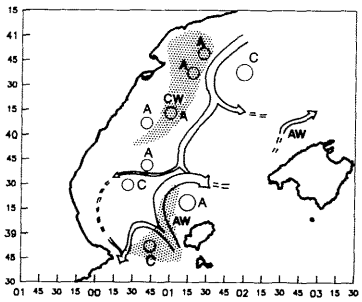

Fig. 2. Summary of results:

Schematics of circulation and position of eddies (circles)
A: Anticyclonic,
C: Cyclonic.

Water mass distribution:
CW: Continental influence
AW: Atlantic influence

Shaded area:
Maximum of organic micropollutants

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Observations of deep water formation in the Gulf of Lions during THETIS

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From November 1991 to April 1992 an experiment was carried out in the northwestern Mediterranean (Gulf of Lions) convection region. The objective was to study with a variety of methods and on a variety of scales the processes involved in the deep convective overturning of the water column which occurs during periods of strong surface cooling (associated with Mistral and Tramontaine winds). Apart from standard current meter moorings and several hydrographic/tracer cruises with continuous shipboard thermosalinograph and ADCP (Acoustic Doppler Current Profiler) sampling, the experiment comprised a moored array with two components dedicated to the extreme spatial scales of the processes. A small-scale (2km) triangle of moorings with ADCP, thermistor chain, and high-precision temperature/salinity recorders was aimed at resolving the individual convective plume scale. A large-scale (100-200km) array of 6 acoustic tomography moorings was designed to yield the large-scale changes in stratification and the convection patch as a function of time.

Preliminary analysis of the meteorological data and of the vertical currents from the moored instruments shows that some shallow mixing events probably occured during December and January, and that the main deep overturning took place in mid-February during the first days of our longest verification cruise. This enabled us to obtain a good ship survey of the convection patch. Within the fresh patch which could be mapped well with the salinity and density signal from the thermosalinograph, the water column had become extremely homogeneous down to depths of about 1600m. Both moored and shipboard ADCP measurements indicated large downward currents during the event. Subsequently, the patch became more fragmented, with intrusions of stratified water from outside the patch at individual depth ranges. At this stage, both the thermosalinograph tracks and the CTD profiles showed high spatial variability. Depending on the processing stage, a preliminary view of the acoustic tomography data will also be presented. Part of the array was not operational during the period leading up to the main convection event, but the temporal evolution of the stratification should be visible during much of the time along various sections through the array.

Danube water influence on sea water salinity at the Romanian Littoral

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The Danube discharge presents high seasonal variations, the extreme values being between 7 km³ in Oct.-Dec. and 39 km³ in May. The extended interval of the Danube run off is specific in every month of the year and especially in April - June period when Danube discharge reached its maxima average values (Tab.I).

Table 1 - The extreme values and the monthly long term averages of the Danube discharge (km³) on the 1961-1988 period

Month	J	F	M	A	M	J	J	A	S	O	N	D
Min.	10	9	13	11	15	12	10	8	8	7	7	7
Max.	29	25	32	33	39	37	33	23	22	25	28	26
Med.	17	17	21	24	25	22	19	15	12	12	12	16

We mention that annual run off values varied between 165 km³ in 1961 and 293 km³ in 1970, the long term average representing 213 km³.

The great volume of Danube fresh water exerts a major influence on the salinity of the Black Sea. This influence is extremely important at the Romanian littoral as a consequence of its position relative to Danube mouths, but even more because of the general trend of the sea surface currents flowing southward.

The surface salinity, at Constantza, near the shore presented long term monthly averages between 14.09 in May and 15.97 in December. The influence of the Danube discharge oscillations is obvious. Thus, the period of the lowest monthly mean salinities (March-June) corresponds to the highest means of the Danube discharge, while in the period of the lowest discharge (Sept.-Nov.), high salinities were recorded (Fig.1). In the same time one could remark some situations when for close values of the run off, the salinities were much different. In this case, Aug. and Dec. are typical (Fig.1). This proves the different action of the marine currents which favoured fresh water to reach Constantza, in August.

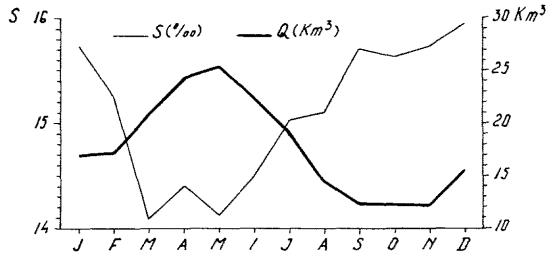

Fig. 1.- Long term monthly means of the sea water salinity at Contantza and Danube run off.

Annual salinity means of the marine waters oscillated between 14.32 and 15.96. The great variations of the salinity reflect the influence of the Danube discharge and of the marine surface circulation as well. Thus, in the years with very reduced discharges, the salinities were very high and in years with high Danube discharge the salinities were diminished (Fig. 2). Strong deviations from this general trend are recorded in several years when the role of the marine currents prevailed.

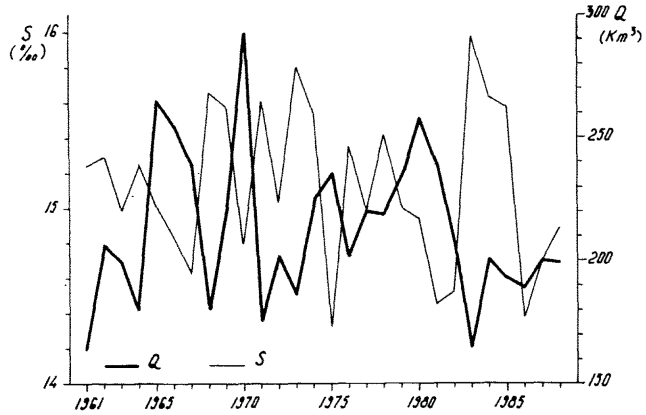

Fig. 2.- Annual values of the sea water salinity at Contantza and Danube run off.

O

The strait of Gibraltar and Alboran sea circulation : a process study

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The water exchanges through the strait of Gibraltar are one of the major forcing of the Mediterranean circulation. Satellite observations over the Mediterranean basin reveal extremely complex circulation patterns which seem to be highly time-dependent. The knowledge of the physical processes connecting the forcing through the strait of Gibraltar with the dynamics of the water motion in the Western Mediterranean Sea still represents a challenge. The LODYC 3D primitive equations model has been undertaken in order to elucidate these driving interactions. In all the experiments the strait circulation has been initiated by connecting two reservoirs filled with homogeneous waters of different density.

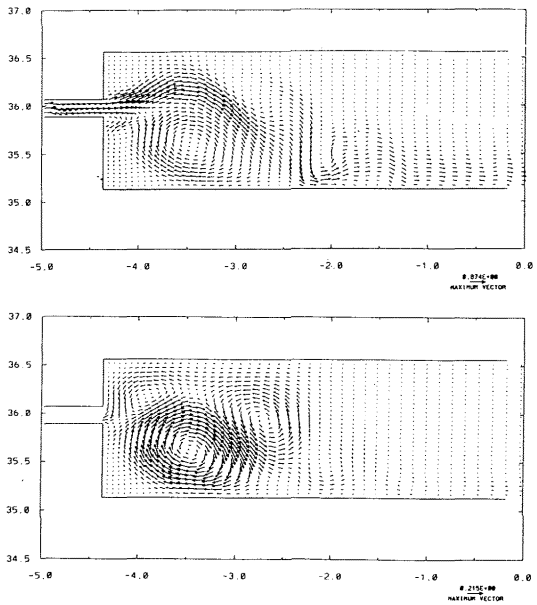
The results are in agreement with observations. In the strait a baroclinic circulation sets up: the light Atlantic water flows into the Mediterranean Sea in the form of a surface layer while the dense Mediterranean water flows out to the Atlantic Ocean near the bottom. The surface water enters the Alboran Sea in the shape of a shallow and narrow buoyant jet with currents over 1 ms-1. After a 3 day spin-up period, the flow transport in the strait reaches a steady value of 1 Sv. The surface inflow presents an internal hydraulic control at the exit within the Alboran Sea. After several days this flow extends in the Alboran basin forming a large anticyclonic gyre that slightly moves northward, while the head of the plume propagates along the southern cost of the Alboran Sea as a coastal Kelvin front.

By this simple academical study we are able to reproduce the high variability of the Alboran Sea circulation during the spin up phase, in particular some mesoscale cyclones that develop North of Gibraltar and displace around the bigger anticyclone (as shown in the figure where the velocity vector field at the sea surface and at 350 m of depth is displayed), as it has been observed both experimentally and through satellite imagery (TINTORE 1991; LA VIOLETTE 1984).

Systematic series of sensitivity experiments have then been performed in order to specify the conditions that control the gyre formation, its space scale and the major characteristics of the inflow and outflow in the strait. The results reveal that the gyre dimensions are very closely related to the density gradient between the two basins and, by a secondary effect, to the presence of the southern coastline in the Alboran Sea. The boundary conditions at the coast as well as a slight inclination towards the north of the Strait, although sometimes argued, do not exhibit any relevant role in the gyre formation and in the overshooting of the inflowing jet.

In addition to these main conclusions it has been possible to identify the physical parameters responsable for the gyre genesis as well as to follow its development till the Alboran Basin general circulation steady state is reached, by studying the potential vorticity conservation and analysing the balance of the dynamical equation terms, as well as referring to mesoscale vortex and modon theories.

In recent numerical experiences we have introduced the real geometry and topography of the investigated region to weigh their impact on the circulation dynamics and structure. A final investigation has been performed by initialazing the density values on the Levitus climatology in order to approach reality.



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Eddies, Meanders and Mushroom vortices in the coastal current system of the Black Sea

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The Nimbus 7 CZCS visible images for June 1980 have been processed to display the variability of chlorophyll within the Black Sea Coastal Current. In addition to displaying the productivity variations along the coast, plankton related ocean colour in a time-series of high resolution images are used as a tracer identifying the unique dynamical features of the Coastal Current System. A meandering current system with an embedded train of mesoscale eddies is observed along the Turkish coast in the pattern of a wave motion progressing to the east between the Bosphorus region and Inceburun (Sinop). There is close correlation of the flow features with the continental slope topography. The abrupt termination of the wide western continental shelf at Sakarya Canyon appears to excite the oscillatory motion progressing rapidly to the east. In the east of the region of interest, the flow takes the form of a wide jet separating further from the coast, when, once again, the continental shelf becomes wider. The wide jet terminates with a dipole-like cap extending to the mid-basin region from the Arhangelsky Ridge east of Sinop. Ocean productivity that can be traced back to the low salinity waters of the Danube plume is transported along the western continental shelf and later becomes incorporated into the dynamically unstable current system in the southwestern Black Sea. In early summer, the continuous plume of chlorophyll observed during the spring appears to be rapidly depleted at the centers of eddies. The structure of the offshore filaments and dipole eddies associated with the Danube plume are also observed in the same series of images.

A unique visualisation of a mushroom eddy occurs offshore of the mouth of the Kizilirmak river in the October 1981 images. The mushroom is connected to the river mouth and the coastal maximum of pigment by a plume. The pigment distribution shows assymmetric spirals withint the dipole eddy. Momentum pulses acting across a coastal jet flow such as the Black Sea Coastal Current are suspected to create a vortex doublet confined in the surface layers with the observed deformation of the chlorophyll field. Such a pulse could be imparted by a local extremum of wind stress or the river plume itself. The filament connecting the dipole eddy to the coast follows the topographic contours of the local canyon topography adjacent to the Arhangelsky Ridge.

It is evident that the bio-optical features of coastal eddies is directly associated with the physical dynamics and the entrainment of surrounding water masses. It is of great utility to find that, unlike thermal images which yield data from a thin layer of surface water influenced by short-term surface heat fluxes, and provided that the pigments are available, the CZCS data produce a depth integrated (to about 20m) signature of colour, faithfully reproducing features of the underlying flow dynamics.

Wide area formation of intermediate and deep water in the Northern Levantine Basin, 1992

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The Rhodes cyclonic gyre is a permanent feature of the Levantine Basin circulation, identified in all seasons in the region south of the Anatolian peninsula and the Island of Rhodes. The heat stored by the upwelling dome of the cyclonic area is substantially lower than the surrounding water masses, and the preconditioning due to homogenisation of the water column (excluding a thin - ~ 50m- surface layer) makes it a candidate for episodes of deep convection. However, either the duration of such events may be short, or they may occur when a sufficiently strong winter forcings are available, and therefore such overturning has not been widely reported. One exception is GERTMAN *et al.* (1990), who observed deep convection during the cold winter of 1987, following earlier suggestions of Deep Water formation in the region by OVCHINNIKOV and PLAKHIN (1984).

Deep convection at the center of the Rhodes Gyre was observed during March 1992, following the cold winter of 1991/1992 (Fig. 1). The thin surface layer overtopping the Rhodes dome during earlier observations of October 1991 has been eroded completely, leading to overturning of central waters to depths in excess of 1000m. Uniform temperature (13.7°C) and salinity (38.7) values are observed throughout the water column within the gyre. Sharp horizontal gradients occur on the northeast side of the uniform region separating it from the more saline (≥ 38.95) Levantine Intermediate Water near the coast.

The intermediate depth convection leading to Levantine Intermediate Water formation was observed in the entire northern Levantine Basin, characterised by uniform profiles of temperature and salinity to depths larger than 300m. The deepest such formation occurred in the Cilician basin, where the base of the convection layer reached 700m.

The well-defined circulation observed in the October 1991 survey prior to the winter cruise is greatly modified by the convection process. Separate patches of cyclonically and anticyclonically tending circulations are found in the March 1992 analyses, which may indicate continuing geostrophic adjustment.

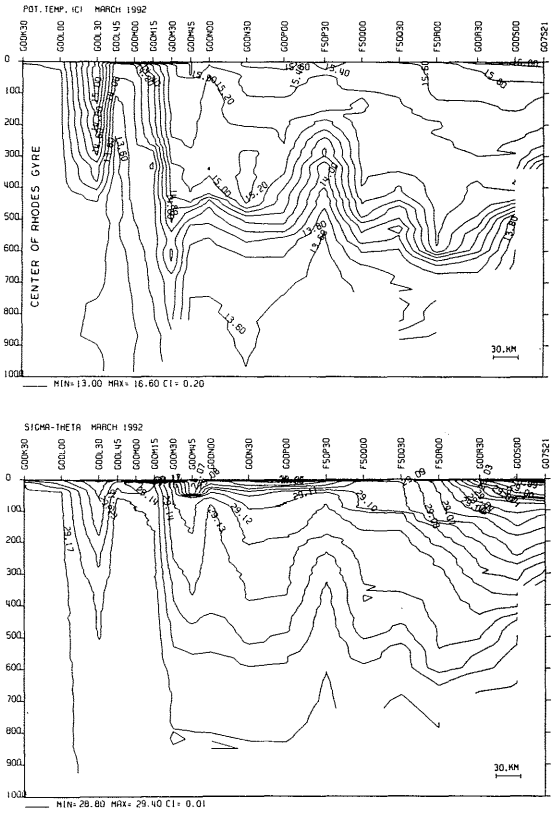

Figure 1. West to east sections along 36°E.

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Aegean influence in the deep layers of the Eastern Ionian Sea (October 1991)

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In the framework of the first general survey of the POEM-II programme, 100 deep CTD stations were occupied by R/V AEGAIO during October/November 1991 in the Eastern Ionian, NW Levantine and South Aegean Seas. Preliminary analysis of the data reveals that in the deep Ionian layers (1000-2000dbars) significant change occurs in the distribution of the hydrological characteristics and the structure of the water column, in comparison with the POEM-I (1986-87) relevant results (THEOCHARIS, 1989; THEOCHARIS *et al.*, 1990; THEODOROU *et al.*, 1988). Temperature and salinity present increased values over a wide region, ranging from 14.0°C and 38.80 to 14.3°C and 38.96 respectively, never reaching down to 2000dbars the characteristic values that correspond to the Eastern Mediterranean Deep Water (T: 13.6-13.7°C and S:38.65-38.70). The circulation is dominated by a large open sea, meandering anticyclonic flow intensified at Pelops gyre, to the south of Peloponnisos. However, mesoscale cyclonic eddies develop near the western Greek coasts, the western Cretan Sea and to the SW of Crete. Therefore, waters are transported southeastwards from the North Ionian, while Aegean waters outflow through the Kitherian Straits. Considerable amounts of the latter relatively warmer and more saline waters form a large tongue in the Ionian. Furthermore, they are trapped by the intense anticyclone and are transported down to great depths affecting considerably the characteristics and the structure of the water column. It is worth to mention that during different seasonal cruises of POEM-I (1986-87) the Aegean contribution was limited in small patches in depths 700-1000dbars. Moreover, previous authors have mentioned that deep Cretan waters were detectable in the vicinity of the Cretan Arc Straits.

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O

Exchanges between Cretan and Levantine Seas inferred from neutral surface analysis

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The water-mass exchanges between Cretan and Levantine Seas have been broadly known for some time, see inter alios MALANOTTE - RIZZOLI and HECHT (1988).

This work is based on analysis of CTD data collected by R.V."AEGAION" at 63 stations in the Cretan Sea and its environs (Fig. 1), during POEM-2-1986 Cruise (11 March -10 April 1986), and aims at delineating these exchanges during this period.

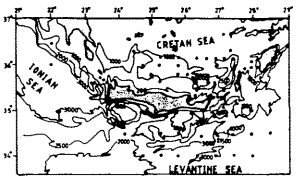

Fig. 1. Study area showing bathymetry and station network

To this end, "neutral surface analysis" (THEODOROU, 1983) a technique to infer the qualitative features of a flow pattern, on the basis of hydrographic data. will be employed. In brief, the outline of the technique is as follows:

Spreading of water masses in the ocean interior is generally assumed to occur predominantly along "neutral surfaces"; the latter can be defined as normal at every point to the gradient of potential density which is referenced to the pressure at the point in question, and thus along which water parcels can be interchanged without any work being done against buoyancy forces. To start a set of neutral surfaces any set of water parcels with observed temperatures and salinities can be used. Based on the "central-reference-pressure" method (THEODOROU, 1991) of approximating neutral surfaces, the levels at which the adiabatic density gradients for each of these water parcels intersect the corresponding adiabatic density profile at each station in a data set determine the levels of each of the neutral surfaces at that station.

Salinity is believed to be a conservative water-mass characteristics. Thus, the spreading of salinity on a neutral surface, coupled with the three-dimensional depth configuration of the latter, indicates patterns of spreading and flow of a water from a particular source; and they constitute together the essence of the "neutral surface analysis".

Our analysis rests on three neutral surfaces, which have been chosen so that to cover spatially the entire range of water-mass exchanges between the Cretan and the Levantine Seas.

The results revealed some interesting features, among which the following stand out:

1. A broadly defined cyclonic flow, which occupies the maior part of the Cretan Sea.

2. A north-eastward flow, which occurs at the easternmost part of the Cretan Sea.

3. Surface inflows are evident at the Kassos and Antikythira Straits.

4. However, at both these Straits, and at intermediate levels, the flows are reversed with respect to the surface ones, indicating general outflows of Cretan sea water through these Straits into the Levantine and southeasternmost Ionian Sea respectively.

5. Thus, at intermediate levels tongues of Cretan Sea water extend from the Cretan Sea, through the Kassos and Antikythira Straits westwards, spreading along the southern Crete and southernmost Peloponnisos respectively.

6. An anticyclone is evident, tied to the bottom topography, at the southwesternmost part of the study area.

7. A cyclonic eddy-like feature occupies the Karpathos Strait.

8. A cyclonic region occurs in the southeasternmost part of the study area.

9. Whilst, at the southernmost part thereof a meandering eastward flow is evident.

10. Except the uppermost one, the topographies of all neutral surfaces reflect broadly the bottom bathymetry.

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Heat exchange processes at the surface of Elefsis Bay, Greece

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This work aims at determining the fluxes due to heat exchange processes at the surface of Elefsis Bay (Fig. 1), in Saronikos Gulf, Greece. Knowledge of these processes is fundamental, not only for understanding several important oceanographic features of the Bay -such as, inter alia. the seasonal balance of salt and heat, the stratification and the thermohaline circulation- but also for the analysis of the ecosystem of this polluted semi-enclosed shallow coastal embayment.

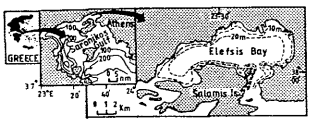

Fig. 1.- Elefsis Bay

The oceanographic data were obtained during twelve monthly cruises, between January and December 1987, by the Greek National Centre for Marine Research. The meteorological data for the same period, were collected at the Elefsis Station of the Greek Meteorological Service; daily mean values, based on three-hourly observations, were used.

The flux of heat across the surface of the sea, Q (Wm^{-2}. positive downwards), is given by:

$$Q = Q_{s-r} + Q_b + Q_e + Q_h$$

where Q_{s-r} is the net shortwave radiation. Q_b is the net longwave radiation, Q_e is the latent or evaporative heat flux, and Q_h is the sensible heat flux or turbulent heat conduction. To estimate these fluxes empirical formulas were employed.

The seasonal variations of the surface heat fluxes are displayed graphically in Figure 2, whilst their annual mean values (all in Wm^{-2}) are given below, and represent the annual heat budget for Elefsis Bay :

Solar shortwave radiation		Net longwave radiation		Evaporative heat transfer		Sensible heat transfer		Total heat flux
199	-	68	-	124	-	14	=	-7

Our results show (Fig. 2) that during 1987, the most important heat loss mechanism, from the surface of Elefsis Bay, was evaporation (c), followed by longwave back radiation (b), whilst sensible heat loss was much smaller (d) the total heat loss, from September through February (e), and within the errors involved, was balanced, by the total heat gain, from March through August (e) of that year.

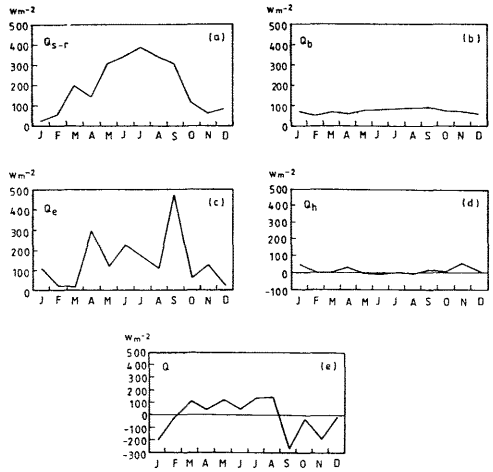

Fig. 2.- The seasonal cycle of surface heat fluxes in Elefsis Bay during 1987.

Our results are in concordance with the findings by BUNKER *et al.* (1982), which hold for the entire Mediterranean Sea. This agreement indicates that the heat exchange processes at the surface of Elefsis Bay are qualitatively and quantitatively identical with the same processes over the broader Mediterranean Sea.

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Modélisation des dilutions d'un rejet urbain par émissaire en Mer Méditerranée

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La démarche choisie pour déterminer les processus qui gouvernent en zone côtière le transport physique des polluants issus des rejets urbains a été l'observation du milieu par des mesures de longue durée (voir communication THOUVENIN *et al.* - Mesures de longue durée de températures et de courants en zone littorale) et l'utilisation de modèles mathématiques. Un site pilote a été choisi. Il correspond au rejet de Toulon Est, émis par 43 mètres de profondeur, à 2 kilomètres de la côte.

L'effluent subit deux étapes de dilution: la remontée, sous forme de *"Panache"*, vers la surface ou vers une profondeur d'équilibre, et le transport par les courants horizontaux du *"nuage"* de pollution, qui se dilue au fur et à mesure qu'il s'éloigne de l'émissaire. Pour reproduire les mécanismes de mélange de l'effluent, une modélisation adaptée à chacune des deux étapes est nécessaire afin de prendre en compte les échelles spatio-temporelles différentes.

Choix des Modèles

La **première étape de mélange,** due à la tension de cisaillement développée par l'ascension du rejet vers la surface, a lieu sur une petite échelle de temps et d'espace (quelques minutes sur quelques dizaines de mètres). Moyennant des théories simplificatrices pour traiter statistiquement la turbulence en recherchant des solutions stationnaires, il est possible d'utiliser des modèles simples et d'obtenir des résultats satisfaisants, dans la mesure où l'on s'intéresse à une échelle spatio-temporelle plus grande, correspondant au devenir de l'effluent sur plusieurs kilomètres et pendant plusieurs heures. Un modèle de JET, développé par la SOGREAH (1988) a été appliqué ici en utilisant les mesures de courants et de stratification réalisées sur le site.

Pour **la deuxième étape de mélange,** les modèles simples, qui calculent analytiquement la concentration de l'effluent en fonction de la distance au rejet, font souvent des hypothèses qui ne conviennent plus aux échelles de temps et d'espace concernées par cette étape. Parmi ces hypothèses, la plus utilisée est celle du régime permanent, qui ne prend pas en compte les situations transitoires; celles-ci peuvent pourtant représenter des cas importants à étudier en terme de risque d'impact sur une zone donnée.

Par exemple, l'installation d'un vent fort suivant une période de vent calme et alternatif (du type régime de faibles brises côtières, courantes en Méditerranée) peut entraîner dans les premières heures le déplacement d'un nuage de pollution, très concentré, qui ne se dilue que lentement.

Nous nous sommes intéressés dans ce programme à une zone relativement proche de l'émissaire, dans laquelle les concentrations d'une majorité de substances issues du rejet sont encore mesurables. A partir des campagnes pluridisciplinaires sur le terrain, et du suivi pendant plusieurs heures de l'effluent marqué, on a constaté qu'à l'échelle de cette zone, les variations temporelles du courant étaient bien plus importantes que les variations spatiales.

Un modèle de transport et mélange multicouches a donc été appliqué; il ne calcule pas les courants dans la zone, mais utilise les mesures réalisées à plusieurs profondeurs; il fait l'hypothèse de l'uniformité horizontale des courants et considère que la profondeur est constante sur toute la zone. Le champ d'application est limité par des frontières ouvertes, c'est-à-dire qu'il n'y a pas de côtes dans la zone, ni d'obstacle perturbant les écoulements. On se place donc dans le cas d'un émissaire rejetant relativement loin de la côte, dans une zone où la topographie n'est pas trop accidentée.

Le modèle prend en compte le transport différentiel entre les couches qui induit une distorsion possible du nuage dans plusieurs directions selon la profondeur. Il simule également le transfert entre les couches à travers la diffusion verticale et la chute des particules.

Application des Modèles

A partir du modèle JET, on a pu déterminer l'importance du profil vertical de densité. Le comportement du panache dépend de la profondeur de la thermocline et de la différence de densité entre la couche du fond et la couche de surface. Pour chaque débit et chaque forme du profil de densité, on obtient une stratification limite inférieure en dessous de laquelle le panache arrive en surface, et une stratification limite supérieure au dessus de laquelle le panache est capté en profondeur et reste relativement stable. Entre ces deux stratifications limites, le panache est instable; sa profondeur, son épaisseur et sa dilution varient beaucoup en fonction des conditions du milieu.

La confrontation des résultats de ce modèle avec les campagnes de mesures sur le terrain a montré une bonne adéquation.

En tenant compte du profil mesuré des courants et de la stratification, le modèle permet de calculer les caractéristiques du panache en fonction du temps et d'évaluer le pourcentage de captage de l'effluent aux différentes profondeurs pendant une période donnée.

A partir du modèle de transport, on a pu déterminer les échelles de temps pour atteindre l'état stationnaire, et les dilutions qui dépendent des courants et des coefficients de diffusion utilisés. Les processus de diffusion verticale, de vitesse de chute et de floculation ont été testés, ainsi que le phénomène de mortalité apparente pour les germes tests.

La confrontation des résultats du modèle avec les campagnes de mesures sur le terrain est satisfaisante, compte tenues des incertitudes sur les données injectées dans le modèle et sur les mesures parfois hétérogènes dans l'espace et variables dans le temps.

Enfin, l'application du modèle à quelques "scénarios types" a permis de visualiser la zone d'impact du rejet pour deux paramètres importants du rejet: les détergents et les germes tests. Les premiers sont supposés conservatifs à l'échelle de quelques dizaines d'heures, les seconds disparaissent avec une cinétique de mortalité fonction de l'intensité lumineuse disponible; cette loi a été mis en évidence par des expériences réalisées au cours de ce programme d'études (POMMEPUY *et al.*, 1990).

Le stock de polluant présent dans la zone évolue en fonction du débit du rejet et des courants. Ces derniers piègent l'effluent dans la zone ou le font sortir rapidement selon les heures de la journée et les jours. On obtient ainsi des stocks très importants en profondeur, lorsque le nuage est capté dans des couches d'eau où les courants sont faibles. Les stocks sont moins importants en surface, mais le nuage étant plus étalé, les limites données par les normes de salubrité ou de toxicité sont parfois dépassées sur des distances assez importantes.

Ces distances qui décrivent l'impact du rejet sont très liées à la condition initiale dans le rejet et pour les bactéries au moment de la journée. En effet, l'impact d'un rejet bactérien est très faible pendant le jour, quand l'insolation provoque une disparition rapide des bactéries. Par contre, on peut considérer que les bactéries sont pratiquement conservatives pendant la nuit ce qui donne une zone d'impact qui peut être très étendue au petit matin.

Le devenir à plus long terme de l'effluent n'a pas été abordé dans cette étude. Cette troisième étape de dilution suppose de connaître cette fois la circulation générale dans la bande côtière et d'y intégrer les variations spatiales des courants, ainsi que les transformations lentes des paramètres du rejet.

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Mesures longue durée de températures et de courants en zone littorale

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Dans le cadre d'un programme d'études sur le devenir des rejets urbains en mer Méditerranée, des mesures de température et de courants ont été réalisées en un point fixe, situé dans la grande rade de Toulon, à 2 kilomètres de la côte, sur des fonds de 43 mètres. L'objectif de ces mesures, qui se sont déroulées sur un an et demi entre mars 1986 et septembre 1987, était d'observer et de définir un certain nombre de "situations types" caractéristiques du comportement de la masse d'eau au débouché de l'émissaire.

Deux chaînes de thermistances ont été mouillées, permettant d'obtenir un profil vertical de température, de la surface au fond avec une valeur tous les deux mètres. Un à quatre courantomètres, selon les périodes, ont mesuré les courants horizontaux à 1,5 mètre sous la surface, à 7 et 15 mètres de profondeur et au fond (-41,5 mètres). Une station météorologique, placée à la côte, mesurait simultanément l'intensité et la vitesse du vent, la température de l'air, la pression atmosphérique et l'insolation lumineuse.

Ces enregistrements de longue durée du **profil de température** ont permis d'observer la formation, l'évolution et la disparition de la thermocline saisonnière en un point proche de la côte:

- A l'echelle de temps journalière, la variabilité de la profondeur et de l'épaisseur de cette thermocline est très importante, et avant tout liée à la courantologie et à l'anémométrie. En effet, on observe une périodicité corrélée aux brises thermiques, celles-ci provoquent le basculement de la thermocline et font varier sa profondeur moyenne de plusieurs mètres (figure 1).
- A l'echelle de temps saisonnière, la formation et l'approfondissement de la thermocline n'est pas un phénomène local et spécifiquement vertical. Etant situé dans une zone très côtière, ce sont principalement les mouvements horizontaux qui déterminent l'apparition du gradient thermique et celle des conditions générales caractéristiques de la période. Il semble que la couche superficielle chaude ne s'épaississe pas seulement par mélange vertical à partir d'un réchauffement par la surface.
- A l'échelle de temps annuelle, les conditions générales thermiques de la méditerranée sont observées, avec une thermocline à mi-profondeur, instable pendant le début de l'été et une thermocline de plus en plus profonde jusqu'à l'automne où elle disparait brusquement sous l'effet d'un coup de vent d'ouest (figure 2).

Les courants montrent une variabilité encore plus importante. Il est à noter l'influence prépondérante des brises thermiques, en été et même en hiver, qui provoquent une rotation des courants pendant la journée, en dehors des périodes de vent fort. D'autre part, de fortes pointes de courant (45 cm/s), dirigées vers l'Ouest, ont été observées; elles suivent de quelques heures des périodes de mistral.

Un seul point de mesure étant disponible, il n'est pas possible d'avancer des interprétations à ces observations. Mais les différents points signalés plus haut permettent de connaître avec plus de précision les échelles de temps qui caractérisent la variabilité des phénomènes en zone très littorale.

La bande côtière est en effet le receptacle de la plupart des rejets urbains et ces informations sont fondamentales pour la compréhension et l'évaluation des dilutions des effluents pendant leur remontée en surface et pendant leur transport horizontal. (voir à ce sujet communication THOUVENIN - Modélisation d'un rejet urbain par émissaire en mer méditerranée).

FIGURE 1 : BASCULEMENT DE LA THERMOCLINE AVEC LES BRISES THERMIQUES

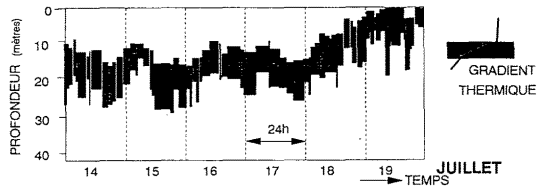
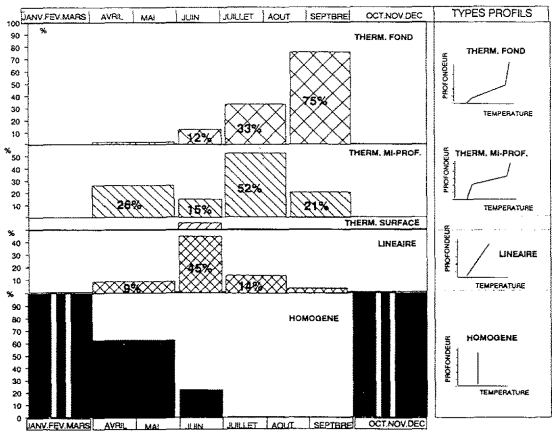


FIGURE 2 : FREQUENCE DES CAS TYPES DE THERMOCLINE



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Meteorological forcing and sea-level variability in the Aegean Sea

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The non-tidal variability of sea-level has been extensively studied and associated with geostrophic wind and atmospheric pressure (PALUMBO and MAZZARELLA, 1982; GARRETT and TOULANY, 1982; LASCARATOS and GACIC, 1990). Nevertheless no studies involving the regionally coherent component of the wind have been published for the area of interest.

The Data Hourly sea level values, daily values of atmospheric pressure, and wind vector data, from five permanent stations, of Hellenic Navy Hydrographic Service and National Meteorological Service in the Aegean Sea are analyzed. The data set covers a four year period (1984-1987). The wind speed and direction data are transformed into north-south (NS) and east-west (EW) components. The data set is divided in one year long time series that are consequently analyzed.

Methodology and Results

The cross correlation of atmospheric pressure, between stations, is high (>0.9) and the coherence significant for all frequencies. The analysis of the NS wind component gives significant cross corellation coefficients and coherence for variations with period >3.5 days. The analysis of the EW wind component gives, in general, statistically insignificant results. The cross correlation coefficients for the sea level data are also significant as well as is the coherence for periods >4.5 days.

Principal component analysis is performed in sea-level, atmospheric pressure and NS wind component. The first two components account for about 95% of the variability. The first PCA mode is found to correspond to the "in phase" oscillation of the whole Aegean (fig. 1). The second PCA mode corresponds to an oscillation with 180° phase difference between the North and the South part of the basin. The response of the sea level to the atmospheric pressure forcing is found to be non-isostatic.

The first two principal components are then compared through spectrum and cross-spectrum analysis. The first principal component spectrum peaks at 0.015 cycles/day for the three variables. The peak associated with the wind spectrum is found to be broader (fig 2). The cross spectrum of pressure and sea level gives statistically significant coherence in all frequencies. The coherence of NS-wind component to sea level is significant only for variations with periods from 2.5 to 9 days. In this range wind advances the sea level by ≈ 130°.

The second PCA component peaks for pressure and sea-level at 0.03 cycles/day and at 0.045 cycles/day for the NS wind component. The wind peak is broader and the energy of its spectrum more evenly distributed. The cross spectrum shows that the second PCA component of wind speed is incoherent with both pressure and sea level. On the other hand the cross spectrum of pressure and sea level shows significant coherence for periods from 2.7-6 days.

Conclusions

The Aegean sea is found to oscillate in two principal modes that together account for ≈ 95% of the total variance. The variability is associated mainly to the first PCA pressure component. At intermediate frequencies, associated with synoptic activity in the area, the first PCA component of the coherent part of the regional wind is found to play an important role. Future research will investigate whether the reconstruction of the time series based on their eigenvalues can be advantageous in regression models for the prediction of mean sea level.

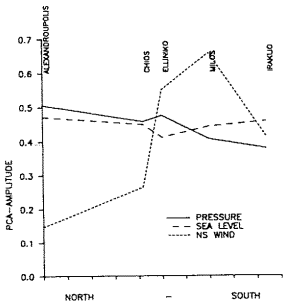

Fig.1 The first PCA component

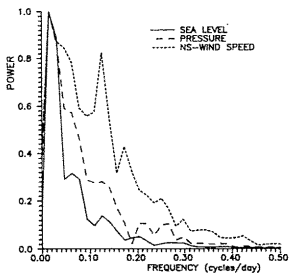

FIG.2 Normalized power spectrum of pressure, sea level and NS-wind component.The normalizing factors are respectively : 865.6 cm², 702.8 mbar², 448.6 (m/sec)²

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The surface seiches of Lake Trichonis (Greece)

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Lake Trichonis, the largest and deepest lake in Greece, is situated in the Aitoloakarnania region of western Greece. The lakes' surface area is 96.9 Km , its length is 20 Km and its greatest width is 6.5 Km (fig.1). The mean depth is about 40m. The Lake is divided into two basins. The western basin is less than 30m deep while the eastern basin has a maximum depth of 57m. The Lake is oligotrophic and exhibiting orthograd distribution of dissolved oxygen (KOUSOURIS, 1981). High hardness and transparency and salt nutrients appearing in low concentrations, heating and cooling are responsible for the stable thermal stratification and uniformation of Lake Trichonis (ZACHARIAS, 1987). The epilimnion at summer's end attains its maximum average thickness of about 15m when the surface temperature may be as high as 30 C. The thermocline is generally very steep. During the entire year the hypolimnion has a quasi-winter temperature profile at the lake bottom where temperatures of 10 C have been recorded. At winter's end the lake is more or less homogenous.

This paper is devoted to the systematical study of the surface seiches of the gravitational oscilations in Lake Trichonis, Greece. A computational analysis of the periods and structure of surface seiches of Lake Trichonis in Greece and its experimental verification from three simultaneous water gauge recordings, mounted along the shores in Myrtia, Panetolio and Trichonio is given. The first five theoretical modes are calculated with a finite difference code of tidal equations, which yield the eigenperiods and co-range and co-tidal lines and are graphically displayed and discussed in detail.

Experimental verifications are from recordings taken during April-May 1989. Visual observations of the record permits identification of the five lowest order modes, including interstation phase shift. Power spectral analysis of two time series and interstation phase difference and coherence spectra allow the indentification of the same five modes. Agreement between the theoretically predicted and the experimentally determined periods was excellent for most of the calculated modes.

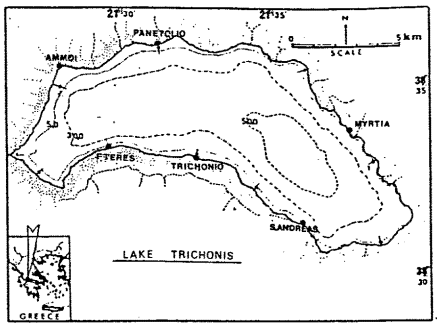

fig.1

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Tide induced vorticity shedding in the strait of Rio-Antirio (Greece), a numerical experiment

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Rio-Antirio a 2200m wide and 60m deep strait, lies in the northern side of Peloponnese (Greece), connecting Patraikos gulf with Corinthiakos gulf. The axis of the channel has a NE-SW orientation of about 60° and the line connecting the tips of the headlands show a departure from 90° from the axis of the channel. The bathymetry shows that the offshore coastal region, in both headland tips, drops quickly in the first 200m at a depth of 50m (fig 1a). The geometry of the area and the measured current velocities are favouring to produce alternating jet flow and separation phenomena behind the headlands. These kinds of flow patterns effect the long term transport rates of pollutants, nutrients and also the erosion and deposition mechanisms. Knowledge of the details of the flow field and of the mechanisms that participate in vorticity shedding and dissipation is increasingly interesting.

The strait presents interesting flow phenomena behind its headlands during the cycle of the M2 tide, which is the driving circulation forcing for this area. Plans for the construction of a bridge across the strait, in conjunction with the interesting vortices observed during field experiments, a two dimensional finite difference numerical model was examined, to study the flow field and also to provide technical parameters for the bridge design.

The two dimensional finite difference numerical model developed uses the depth integrated shallow water momentum and continuity equations. The model was verified from experimental data taken from current meters, tide gauges, drogues and air photos.

Numerical experiments performed for the different tide heights and a number of the approximately geometries. The results analysed lead to conclusions about the threshold for the flow to be separated and vortices to make their appearance in the flow field (fig 1b). The analysis of the calculated vorticity distribution patterns shows the life time of these vortices within a tide cycle as also the way the vorticity is advected by the background flow. These vorticity distribution maps reveal the interaction of the vortices generated in the first half of the tide cycle with those of the second one. The last thing that is examined with the aid of the model results is the bottom stress distribution and the regions with maximum shear are established.

These regions coincide with the region of active seabed erosion as mapped during a survey using a high resolution subbottom profiling system.

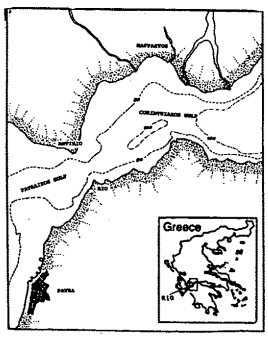

fig 1.a

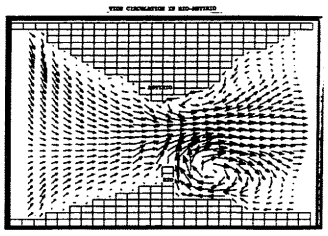

fig 1.b

The autumnal circulation pattern of the Cretan Sea and adjacent basins during the POEM experiment

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Despite a rather long history of the study of the Cretan Sea the autumnal circulation pattern was remained somewhat unclear up to now. Thanks to the POEM experiments CTD data were collected, between November and the first ten days of December 1986, from an intense grid of stations in the Cretan Sea and adjacent basins of the NW Levantine and S Ionian Basins.

The maps of the dynamic height topography and of the geostrophic flows (Figs. 1, 2) reveal that the general circulation pattern of the area under investigation consisting of different horizontal scale cyclonic and anticyclonic gyres interconnected by currents.

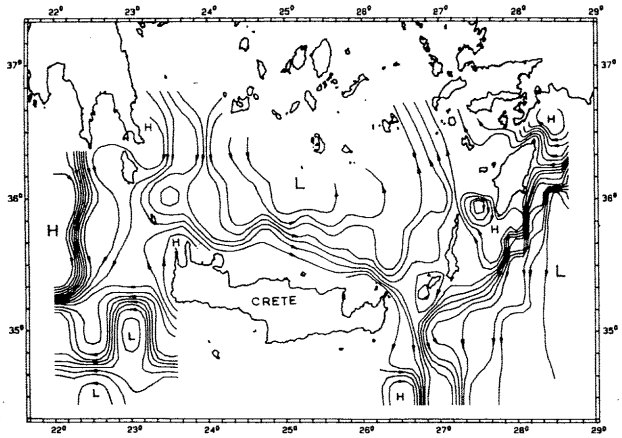

Fig. 1.- surface dynamic height topography of Cretan Sea and adjacent basins relative to 500 m, autumn 1986.

The main features of the circulation pattern in the Cretan Sea this transient season were: a) the large cyclonic flow region, which occupied the greatest part of the sea, b) the northward flow region in the eastern part, c) the two small scale anticyclonic flow regions in the area of the western Cretan Arc straits and d) the intense anticyclonic gyre within the area of the Karpathos Strait. In contradiction to the winter 1987 flow pattern (ZODIATIS, 1991b) this autumnal period the main current, which prevailed in the Cretan Sea, was meandering from the NW to the east and was of the same direction to that of summer 1987 (ZODIATIS, 1991a).

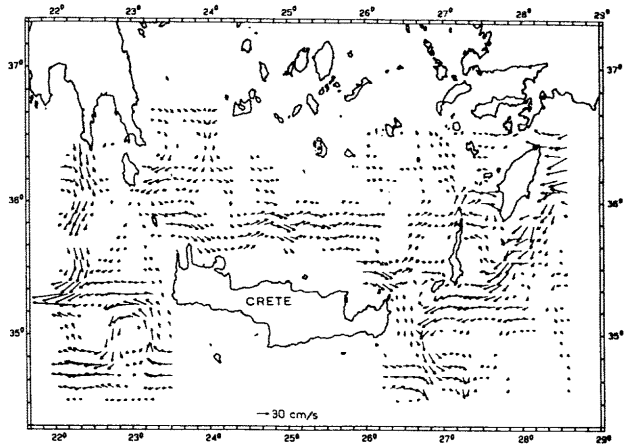

Fig. 2.- Surface geostrophic flow pattern of the Cretan Sea and adjacent basins, autumn 1986.

The circulation pattern of the adjacent basins was similar to that of winter-summer periods 1986, 1987 (ZODIATIS, 1992). It was determined by the activities of the Asia Minor current and of the large Rhodos cyclonic gyre in the NW Levantine Basin. In the south Ionian Sea the large anticyctonic gyre south from the Greece mainland and the cyclonic flow region SW of Crete island were dominated. However, the present seasonal variabilities of the location, deformation of the boundaries of the above gyres and of the currents influenced in a lesser degree the circulation of the Cretan Sea in comparison to other seasons.

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Thermohaline Lens in the Eastern Mediterranean Sea

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The Meddies-Mediterranean salt lenses consider to be the most well investigated T,S inversion caused by the intrusion of the LIW to the North Atlantic Ocean (ARMI and ZENK, 1984).

In contradiction to the above, the present task attemps to spequlate on the existence of a cool and less saline inversion of the T,S water characteristics in the Eastern Mediterranean Sea similar to that mentioned by FEDOROV *et al.* (1986).

During the POEM-5 cruise, late summer 1987 in the SE Ionian Sea - south of Greece mainland, a well developed lens of cool and less saline water was found at the intermediate depths.

The analysis of the CTD data and vertical section (Fig.1) shows that the lens bounded by the isotherm of 14.30 (deg.C) and isohaline of 38.84 between the depth of 250-500 m. The horizontal diameter of this lens was approximately 40 Km, while it center lie at the depth of 390 m. The thermohaline differences within the lens, in comparison with the surrounding waters, were about 0.4 (deg.C) for temperature and 0.24 for salinity.

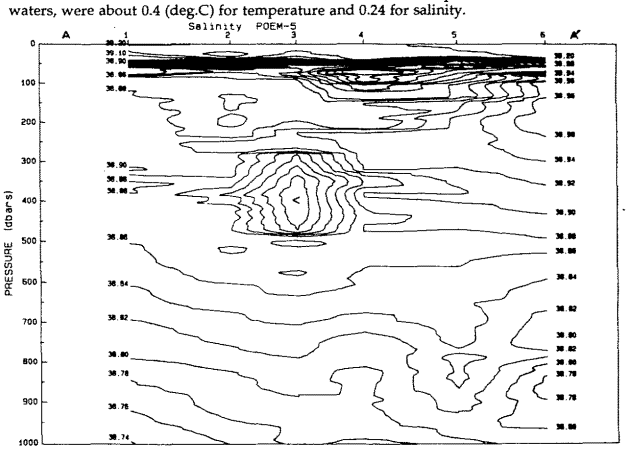

Fig. 1.- Vertical distribution of salinity, SE Ionian Sea, POEM-5.

The intense cooling of the surface water, during the previous winter 1987, in conjuction with the circulation caused the generation of well developed thermohaline dome; whereas water from deeper layers rised to the uppers. Later the variability of the circulation allowed the intrusion of the LIW into the area of study. Finally, the latter activity caused the isolation of a patch of less saline and cool water forming by this way the observed lens.

Such type of water creature, where the T, S characteristics within the lens differs from the surrounding, create conditions for the study of the fine thermohaline structure of the water.

The high gradient layers alternation at the lens boundaries promote the develop of the convective instability.

The main mechanism responsible for the formation of the observed (Fig. 2) stepwise and high gradient layers was the double diffusive activities. As indicators of the double diffusional instability processes possibility and intensity are the density ratio-Rp and Turner angle-Tu. The vertical profile of Tu (Fig. 2) indicates that on the lens upper boundary salt fingers convective instability occurs, while at it under boundary diffusive convection instability. Both were responsible for the vertical salt and heat transfer across interfaces. Its worthy to mention that these fluxes are twice as less to those of T,S stepwise structure observed in the Cretan Sea (ZODIATIS, 1991).

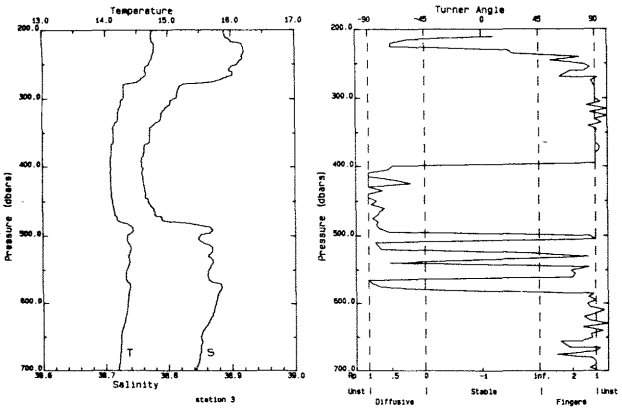

Fig. 2.- Profiles of T,S and Tu; Rp with the double diffusive regimes at st.3, SE Ionian Sea, POEM-5.

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Les Silicoflagellés de la Côte centrale libanaise

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L'étude du cycle annuel des principaux groupes phyto- et microzooplanctoniques de la côte libanaise a fait l'objet de plusieurs publications (ABBOUD-ABI SAAB, 1985, 1988, 1989). Nous exposons ici les résultats relatifs aux Silicoflagellés (*Dictyochophyceae*) qui sont caractérisés par la possession d'un squelette siliceux. Ils constituent un petit groupe, nettement délimité, de flagellés. Ce groupe qui est en régression nette par rapport à l'ère tertiaire, n'est plus représenté que par l'unique genre actuel *Dictyocha* Ehr. Rappelons que la systématique des Silicoflagellés est encore basée sur les caractères squelettiques.

Les Silicoflagellés ont été dénombrés systématiquement avec les autres groupes phytoplanctoniques suivant la méthode d'UTERMOHL (1958) en sédimentant un volume de 100cc qui est parfois insuffisant pour détecter des valeurs faibles; par contre, la sédimentation d'un litre a montré la présence de ce groupe presque toute l'année à des densités très variables; mais cette méthode, outre qu'elle est lente, n'est pas toujours applicable dans des zones côtières riches en matières en suspension qui gênent les comptages et faussent les résultats. Le dénombrement des échantillons de filet de 52 µm de vide de maille, utilisé pour collecter les espèces rares, a montré la présence de ce groupe surtout durant les mois d'automne avec une densité atteignant 2600 cell./m^3 en décembre 1980 à une station située à 12km au large; soulignons que ce chiffre est sous-estimé car la taille de la plupart des Silicoflagellés se situe entre 10 et 50 µm; ils ne seront pas retenus par le filet.

Pour cette étude du cycle annuel, nous avons dénombré mensuellement les Silicoflagellés dans des échantillons de 100 cc. d'eau de surface durant 2 années consécutives, entre sept. 1986 et oct. 1988 en 2 stations situées sur la côte centrale du Liban: J0 (à environ 40m du rivage par 5m de fond) et J1 (à 2km de la côte par 150m de fond).

Durant cette période, la température de l'eau a suivi le cycle normal connu dans la région avec un minimum de 16-17°C (février-mars) et un maximum de 29-30°C (août) et la salinité a varié entre 35,6 ‰ (mars-avril) et 39,2 ‰ (septembre-octobre).

L'étude qualitative a montré que le taxon qui domine dans ce genre unique est *Dictyocha fibula* var. *major*, réputé pour sa préférence pour les eaux chaudes et qui à lui seul constitue souvent tout l'effectif des Silicoflagellés; cependant on note aussi la présence d'autres taxons moins abondants: *D. fibula* var. *messanensis* Haeck., *D. fibula* var *stapedia* Haeck., *D. octonaria* Ehr. et *D. speculum* Ehr. Ces deux derniers affectionnent les eaux froides.

L'étude quantitative a montré que les Silicoflagellés sont très rares ou absents en hiver; leur nombre commence à augmenter à partir de juillet pour atteindre un maximum entre novembre et janvier. Les effectifs varient entre 0 et 580 cell./l à J0 et 0 et 830 cell./l à J1. les maxima se situent pour les 2 stations en novembre 1986. Ce groupe diminue en hiver et au début du printemps; il a été présent en été 1987, n'a pas été observé pendant l'été 1988.

RAMPI (1948) a noté que les Silicoflagellés sont abondants en Méditerranée surtout en automne, saison pendant laquelle semble avoir lieu une forte poussée de leurs divisions végétatives nocturnes. Des travaux en Méditerranée (NIVAL, 1965; TRAVERS et TRAVERS, 1968) ont montré que la température est un facteur en relation avec l'abondance de *D. fibula* en surface; en Méditerranée occidentale, COSTE *et al.* (1969) ont montré la présence d'un gradient de Silicoflagellés lié à la structure thermique et un maximum noté à une température supérieure à 13,5°C. Sur la côte libanaise, l'abondance de ce groupe semble être liée principalement aux températures décroissantes (entre 24 et 19°C) dues à l'enfoncement de la thermocline et à sa disparition en automne. Le maximum d'abondance de ce groupe coïncide avec celui des Actinopodes, des Tintinnides et des Foraminifères (ABBOUD-ABI SAAB, 1988, 1989, sous presse).

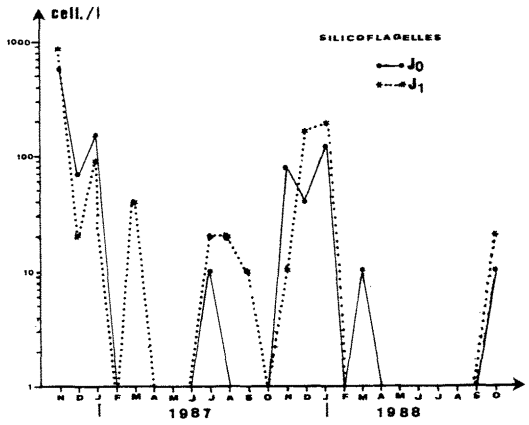

Fig. 1. Variations des densités des Silicoflagellés aux stations J0 et J1 entre sept. 1986 et oct. 1988.

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Influence de la dilution fluviale sur la dynamique des populations phyto- et nanoplanctoniques dans les eaux libanaises.

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La topographie du pays fait que les eaux qui arrivent à la mer sont sous forme de torrents et de cours d'eau saisonniers. Celles-ci peuvent créer des variations importantes des paramètres physico-chimiques et influencer profondément la dynamique des populations, surtout celles de l'échelon primaire. Nous nous sommes proposés de suivre l'évolution de ces populations en fonction des variations des caractéristiques du milieu. Le fleuve choisi, Naher-el-kalb, long de 27km, descend de la chaîne du Mont-Liban et débouche au nord de Beyrouth à 12km de la Baie de Jounieh, région principale de plusieurs projets de recherches (Fig.1). Trois stations, supposées être dans le trajet du courant général de direction S-SO N-NE charriant l'eau du fleuve, ont été choisies. N1 est située en face de l'embouchure (300m de la côte par 8m de fond), N2 (à 2,5km de N1 et à 100m de la côte par 8m de fond) et N3 (à 3km de N2 et à 2km de la côte par 50m de fond). Les sorties en mer ont commencé en septembre 1988, fin de la période de sécheresse, à un rythme mensuel jusqu'en février 1989 où la température annuelle atteint son minimum (ABBOUD-ABI SAAB, 1989). Des mesures hydrologiques ont été effectuées et des échantillons d'eau ont été traités au Lugol aux niveaux 0 et 5m pour l'étude du phytoplancton et du nanoplancton.

Durant cette période, les salinités en surface diminuent de 39,2 à 25,7 ‰ (ΔS = 13,5) à N1, de 39,2 à 35,9 ‰ (ΔS = 3,3) à N2 et de 39,3 à 38,1‰ (ΔS = 1,2) à N3. Les températures diminuent respectivement aux trois stations : 28-15°C (ΔT =12,2), 28-17,2°C (ΔT = 10,8) et enfin 28,2-17°C (ΔT = 10,3). Les différences de salinité entre les niveaux 0 et 5m sont significatives à N1 et en février (ΔS = 11,5‰); ce qui laisse supposer que l'épaisseur des eaux diluées reste inférieure à 5m.

L'évolution quantitative des populations phytoplanctoniques montre qu'il y a deux minima, un en novembre et un autre en janvier, à toutes les stations. La poussée remarquée en décembre, déjà observée dans les eaux côtières (ABBOUD-ABI SAAB, 1985), est due aux pluies automnales; une autre, en février est due au début de la fonte des neiges et correspond à la poussée pré-printanière. Le nanoplancton ne correspond pas toujours à ce schéma (minimum en octobre à N1 et à N2 à 0m et à N3 à 5m).

D'après des recherches antérieures (KHALAF et LAHOUD, 1983); ABBOUD-ABI SAAB, 1986), les eaux du fleuve sont plus riches que les eaux marines en phosphates et nitrates. En considérant les moyennes (Tableau 1), on constate qu'à 0m les populations nano- et phytoplanctoniques sont plus importantes à N1, les Diatomées et les Dinoflagellés le sont à N3; par contre, à 5m, seul le nanoplancton est plus important à N1, tandis que les Diatomées le sont à N2.

En ce qui concerne son aspect qualitatif, le phytoplancton est aussi exclusivement constitué de taxons marins, en majorité des Diatomées et des Dinoflagellés. Les mêmes espèces sont présentes aux trois stations, mais à des densités variables comme leur pourcentage par rapport au total phytoplanctonique. Les valeurs de ces derniers sont comparables lors des mois de sècheresse, mais dès les premières pluies l'effet de dilution se fait sentir, surtout à N1, sur l'aspect qualitatif et aussi quantitatif du phytoplancton. Les espèces dominantes ne sont plus les mêmes à N1 et N2 d'une part et à N3 d'autre part; en décembre, à 0m, *Skeletonema costatum* domine à N1 (38,5%); par contre, *Cerataulina bergonii* domine à N2 et N3 (successivement 62,2 et 63%). A 5m, *C. bergonii* domine à N1 et N2 (68% et 89%); tandis qu'à N3, ce sont *Lauderia borealis* (33%) et *S. costatum* (25,4%).

		N1	N2	N3
Nanoplancton	0m	2 372,5	1 831,5	1 615
	5m	2 259	1 773	1 347,5
Phytoplancton total	0m	121	120	69
	5m	62	84,4	21
Diatomées	0m	98,3	105,4	28,2
	5m	53,4	76	17,5
Dinoflagellés	0m	22,8	18,2	41
Nanoplancton	0m	396 - 5 423	950 - 2 027	491 - 3958,5
	5m	285 - 4 038	113 - 3 127	475 - 2098
Phytoplancton total	0m	5,8- 245	11 - 336	5,5- 293,4
	5m	5,1- 155	6,3-265	2,3- 41
Diatomées	0m	1,9- 224,4	3,7-316,4	0,6 - 73,3
	5m	1,9- 121,5	3,4-236,3	0,9 - 59,7
Dinoflagellés	0m	0,8- 72,8	5,4-46,7	2,9 - 220
	5m	1,9- 33,3	1,9-28,3	1,1 - 5,9

Tableau 1. Moyennes (partie supérieure); Maxima et minima (partie inférieure) (x 10^3 cell./l).

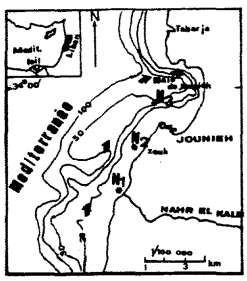

Fig. 1. Partie centrale de la côte libanaise montrant les stations prospectées (*) et la direction du courant (->).

Les résultats suggèrent que le nombreux phénomènes peuvent influencer les abondances estimées en un point. D'une part, le débit du fleuve varie de façon importante à chaque période de pluie et d'autre part le vent peut, selon sa direction et sa force, empiler la nappe d'eau diluée à la côte ou au contraire l'étaler vers le large. Des observations sur des périodes plus longues permettront de quantifier l'action de ces facteurs.

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Culture medium optim ·ation for the halotolerant alga *Dunaliella salina*.

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Introduction

The unique adaptability of the green alga *Dunaliella* to grow in a wide range of salt concentrations, has made it a favorite subject for detailed physiological and biochemical investigations, aimed at its utility as a source of some fine chemicals such as β-carotene and glycerol or a source of single cell protein for rearing rotifers and brine shrimp, *Artemia*. It is well known that the concentrations and the ratios of the essential nutritive elements, strongly affect algal growth and photosynthetic rates (FISHER *et al* ., 1981). The main target of this work is to maximize *Dunaliella salina* growth with the most economical culture component supply.

Material and methods

The methodology of experimental design, namely, the random balance, the fractional factorial and the steepest ascent designs (SATTERTHWAITE, 1959; COCHRAN and COX, 1957) were used to develop a new synthetic optimized medium for the growth of *Dunaliella salina*. All major cations (Na, K, Mg and Ca) were added as chloride /salts and anions (HCO_3, SO_4 ,NO_3 and PO_4) as sodium salts. The trace metals (Zn, Mn, Mo, Co, Cu and Fe) were added in chelated form with EDTA. Vitamin B_{12} was added to all media at a level of L µg/l. Culture media were inoculated under sterile conditions with actively growing *Dunaliella salina*, adjusting its initial concentration to 10^4 cell/l. Experiments were performed in triplicates. Cultures were grown in incubator at light intensity 4 k Lux and temperature of 25 ± 1°C. Experiment duration lasted for 9 days. Population density was estimated by cell count on a hemacytometer.

Results and discussion

The random balance design was used first to evaluate the main effect of 15 nutritive elements as mentioned previously plus the effect of H_3BO_3 at 2 levels of concentrations (+1) and (-1), which were chosen to express the highest and the lowest element concentrations used in the known artificial sea water media (ASP-2, ASP-6, ASP-12, ASM and Muller media). Data gained using this design showed that alga was tolerant to a wide range of macroelement concentration changes. Concerning micro- elements and H_3BO_3 the best algal yield was achieved at the levels given in table 2. For optimizing the major cations and anions concentrations in relation to algal yield the 2^{8-4} fractional factorial design was used, where the concentrations of the media on which the alga attained its maximum yield in the previous design was taken as a middle point in defining the (+1) and (-1) levels for this design. Results are given in table 1. After statistical treatment of the data we can conclude that algal yield was only significantly affected by the concentration changes of K, Mg, PO and CO_3. For optimizing their concentrations, a set of experiments was done using the steepest ascent method, where the composition of medium N° 15 on which the algal yield was maximum (table 1) was taken as original point. The highest mean algal yield (18 x10^6 cell/ml) was achieved on growth medium N°8. This is about 9-10 times greater than those recorded in the literature at about the same conditions of cultivation used in our experiments. In conclusion we are recommending a new medium for best *Dunaliella salina* growth as given in table 2.

Table I . 2^{8-4} fractional factorial design and steepest plan.

Factors	NaCl X_1	KCl X_2	$MgCl_2$ X_3	$CaCl_2$ X_4	Na_2SO_4 X_5	$NaHCO_3$ X_6	$NaNO_3$ X_7	NaH_2PO_4 X_8	culture density after 9 days 10^6 cell/ml
Level mM/l									
-1 level	1000	8	25	8	15	1.5	2	0.05	
+1 level	2000	16	55	18	25	2.5	5	0.10	
0 level	1500	12	40	13	20	2.0	3.5	0.075	
Variation unit (λ)	500	4	15	5	5	0.5	1.5	0.025	
Experiment									
1	-1	-1	-1	-1	-1	-1	-1	-1	4.39
2	+1	-1	-1	-1	+1	+1	+1	-1	3.51
3	-1	+1	-1	-1	+1	+1	-1	+1	6.06
4	+1	+1	-1	-1	-1	-1	+1	+1	4.56
5	-1	-1	+1	-1	+1	-1	+1	+1	6.97
6	+1	-1	+1	-1	-1	+1	-1	+1	4.61
7	-1	+1	+1	-1	-1	+1	+1	-1	4.63
8	+1	+1	+1	-1	+1	-1	-1	-1	3.47
9	-1	-1	-1	+1	-1	+1	+1	+1	0.28
10	+1	-1	-1	+1	+1	-1	-1	+1	5.09
11	-1	+1	-1	+1	+1	-1	+1	-1	4.44
12	+1	+1	-1	+1	-1	+1	-1	-1	4.64
13	-1	-1	+1	+1	+1	+1	-1	-1	4.07
14	+1	-1	+1	+1	-1	-1	+1	-1	4.59
15	-1	+1	+1	+1	-1	-1	-1	+1	7.66
16	+1	+1	+1	+1	+1	+1	+1	+1	5.17
Regre. coef.(b_i)	-0.23	0.5	0.46	-0.19	0.26	-0.46	-0.41	0.47	
b_i λ		2.0	6.9			-0.23		0.012	
Initial level.	1000	16	55	18	15	1.5	2	0.100	
Level on path.									
1	1000	18	62	18	15	1.25	2	0.112	12.90
2	1000	20	69	18	15	1.00	2	0.124	14.93
3	1000	22	76	18	15	0.75	2	0.136	14.09
4	1000	24	83	18	15	0.50	2	0.148	13.76
5	1000	26	90	18	15	0.25	2	0.160	15.43
6	1000	28	97	18	15	0.00	2	0.172	13.55
7	1000	30	104	18	15	0.00	2	0.184	14.49
8	1000	32	111	18	15	0.00	2	0.169	18.10
9	1000	34	118	18	15	0.00	2	0.208	15.91
10	1000	36	125	18	15	0.00	2	0.220	16.01
11	1000	38	132	18	15	0.00	2	0.232	17.19
12	1000	40	139	18	15	0.00	2	0.244	16.24
13	1000	42	146	18	15	0.00	2	0.256	15.92
14	1000	44	153	18	15	0.00	2	0.268	16.17
15	1000	46	160	18	15	0.00	2	0.280	17.24

Table 2. Mineral composition of medium No.8.

Salt	NaCl	KCl	$MgCl_2$	$CaCl_2$	Na_2SO_4	$NaNO_3$	NaH_2PO_4
Conc. mM/l	1000	32	111	18	15	2	0.196
Salt	Fe	Zn	Mn	Mo	Co	Cu	H_3BO_3
	2	1	1	6	0.1	0.02	400

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The Nematocysts of *Rhopilema nomadica* (Cnidaria, Scyphozoa) - A new Lessepsian Scyphomedusa in the Eastern Mediterranean

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Large aggregations of the jellyfish *Rhopilemanomadica* GALIL, 1990 - a new lessepsian migrant into the Mediterranean (GALIL *et al.*, 1990) - have been observed off the Levantine coasts in the past seven years. This jellyfish, which umbrella could reach a size of one meter, inflicts painful stings. The severity of the stings is related to the area affected and depends on individual sensitivity. The symptoms involve a burning sensation in the contact area, swelling and development of fluidfilled blisters that may persist for days and remain as weal marks. Systemic symptoms in the most severe cases may involve high temperature, fatigue and muscular aches.

Nets strung along beaches for the protection of bathers were ineffective as tissue fragments, mainly the tentacles of the oral lobes and of the umbrella, that contain nematocysts, passed through and caused a "stinging water" sensation for bathers. Local municipalities reported a decrease in beach attendance during periods of jellyfish swarmings.

In 1991 the joint research effort of the Universities of Trieste, Haifa and the National Oceanographic Institute of Israel aimed at the study of the biology, morphology and distribution of *R. nomadica*. This work summarizes the first observations on its nematocysts.

The nematocysts were culled from freshly caught jellyfish. Oral tentacles were excised and immersed in distilled water for 24H at 5°C, then homogenized. The homogenate was centrifuged repeatedly (at 3500 rpm, 15 min.); the supernatant removed, the pellet was re-suspended in distilled water until satisfactory purification. Nematocysts discharge and fixation of SEM samples follow procedures described in AVIAN *et al.* (1991).

Our preliminary results attest to the presence of four types of nematocysts in adult specimens of *R. nomadica*.

-*Heterotrichous microbasic eurytele*. It has an everted tubule with a well-defined shaft armed with three helicoidal series of spines. Its capsule, 4-6 µm long, is ellipsoidal.

- Large *Holotrichous isorhiza* has sub spherical capsules, 8-12 µm long. The everted tubule is armed with three helicoidal series of triangular spines.

- *Heterotrichous isorhiza* has capsules ranging from ellipsoidal to truncated cones, 4-5 µm long. The everted tubule is proximally armed with three helicoidal series of flat, lanceolate spines, and distally armed with short, blunt spines.

- Small *Holotrichous a-isorhiza*, the smallest of the nematocysts, has an ovoid to sub spherical capsule only 2-3 µm long, with the everted tubule armed with three helicoidal series of little spinules.

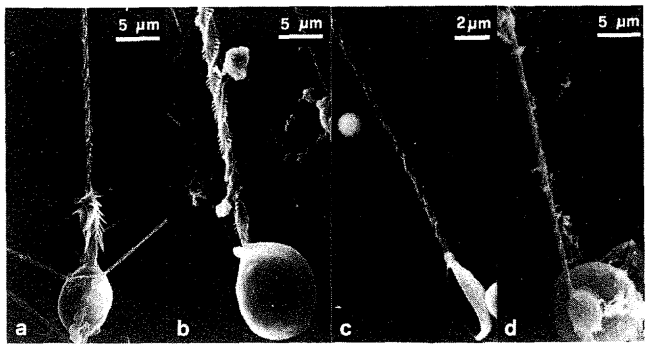

Fig. 1. SEM micrographs of the nematocysts of *R. nomadica*. a, discharged Heterotrichous microbasic eurytele; b, discharged large Holotrichous isorhiza; c, discharged Heterotrichous isorhiza; d, discharged small Holotrichous isorhiza.

The eurytele type is common both in the tentacles and in the gastric filaments, the large holotrichous isorhiza is more frequent in the scapulate tentacles than in the oral lobes, and the small holotrichous isorhiza is the commonest type, widely distributed in all areas.

It is of interest that a co-generic species, *R. esculenta* Kishinouye, similarly has four nematocysts types in the adult (CHEN & DING, 1981); the classification proposed for the *R. esculenta* nematocysts is otherwise not correspondent with our observations. CHEN & DING's classification is based solely on light microscope observations, and it is possible that their anisorhiza-type nematocysts are in fact the isorhiza-type nematocysts we have identified in *R. nomadica*.

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Histology of the gonads of *Rhopilema nomadica* (Cnidaria, Scyphozoa) First observations

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The jellyfish *Rhopilema nomadica* GALIL, 1990 - a new lessepsian migrant into the Mediterranean (GALIL *et al.*, 1990) - has been appearing since the mid-1980's in large swarms along the Levantine coast. During massive swarming periods dense aggregations of up to 25 specimens per cubic meter were observed to extend more than a 1000 m^2 - an enormous mass of jellyfish. Mass swarming occurs mostly in summer, during July and August, but a sizable presence has been witnessed during winter too, with individuals bearing mature gonads occurring during both summer and winter.

Laboratory studies of the life cycle of *R. nomadica* (LOTAN *et al.*, 1992) and its co-gener *R. esculenta* Kishinouye (DING & CHEN, 1981), have supplied us with descriptions of the various developmental stages. However, the duration and rhythm of the reproductive period in the natural environment are still unknown. In order to assess the duration of the reproductive period, we have analyzed the histological structure of the gonads of *R. nomadica* as part of a joint research effort between the Universities of Trieste, Haifa and the National Oceanographic Institute of Israel to study the biology, morphology and distribution of the new lessepsian migrant.

The four ribbon-like gonads are situated on the subumbrellar surface of the gastrovascular cavity, over the proximal portion of the perradial canals, at the base of the arm disc. The gonad is situated over the lateral borders of the scapulets, on the lateral wall of the gastric pouch, distally close to the emergence of the perradial canals in the scapulets and proximally divergent; viewed from below they seem V-shaped. Each gonad seems to be divided into two segments, so that at low magnification they seem as four pairs.

At the base of each gonad are found several small gastric filaments, bearing numerous nematocysts (mainly of eurytele type). Distally close to them there is the emergence of the evagination of the gonad, which is delimited by a monostratified layer of endodermal cells, cylindrical in the gastric pouch surface and flattened in the inner surface (which delimits the genital sinus). The latter layer (the secondary endoderm) gives rise to the follicles (in the testicles) and to the oocytes (in the ovaries).

In the male gonad the follicles are initially sub spherical and compact. Later, they turn polygonal. The follicles are monostratified in the gonadal ribbon. Each follicle is delimited by a monostratified wall of cubic cells which, mainly in the side opposite the secondary endoderm, gives rise to the first elements of the spermatogenesis. All specimens with umbrella diameter larger than 12 cm contain fully developed sperm. The trigonal sperm heads are positioned in the middle of the follicle, while their flagella, often packed in parallel bundles, are placed near the side in contact with the secondary endoderm. In mature follicles the cells in contact with the secondary endoderm are much flattened and, during sperm discharge, may separate and/or degenerate, allowing the sperm to exit into the genital sinus.

In the ovaries we observed no maturation gradient and the oogonia seem to originate everywhere in the secondary endoderm, which cells are flattened or cuboid. Different stages of oocyte development may be observed in each gonad. A mature oocyte measures about 100 µm in diameter. The oocytes adhere to the secondary endoderm, though they do not seem to form a distinct cell population. The cytoplasm development during vitellogenesis is similar to that observed in *Rhizostoma pulmo* (AVIAN & ROTTINI SANDRINI, 1991).

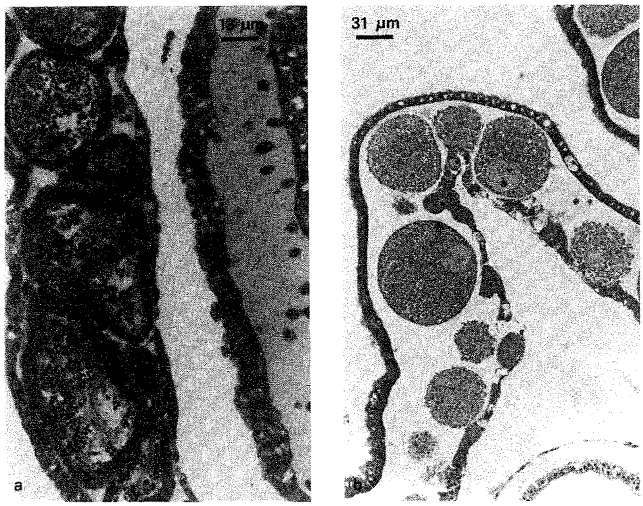

Fig. 1. **a**, light micrograph of a male gonad. **b**, light micrograph of an ovary.

Fecundity in *R. nomadica* seems very high, with estimated egg masses of 34 x 10^5 in specimens with umbrellar diameter of 30-40 cm. This high fecundity, together with an extended reproductive period may be the key to the rapid expansion of its populations along the Levantine coast.

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Resting eggs from the bottom muds of the Mar Piccolo (Taranto - Italy)

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Many organisms of neritic and lagoon plankton in temperate areas overcome adverse environmental conditions as resting stages. A number of copepods disappear from the plankton during some periods. They produce resting eggs which ensure the species survival during the unfavourable periods. The hatch of the resting eggs gives again the planktonic population when the favourable conditions return (UYE, 1985).

Sediment cores (from 0 to -5 cm) were collected from different sampling stations in the Mar Piccolo of Taranto at September 1991. In all the stations the ratio sediment silt/ clay fraction (0 < 63.5 µm) was ≥ 90 %. According to a tested method (QUARTA *et al.*, in press) the eggs were isolated from the sediment. They were subdivided in 10 morphological types. One of these was recognized as a *Scrippsiella* (Dinoflagellata) cyst. The 9 egg-types were reared in the laboratory under controlled conditions (21°C; 12hL:12hD) in filtered and sterilized seawater. The rearing units were supplied with *Isochrysis galbana* as algal food for hatch from which the species was recognized.

The 76.1 % of the 9 egg types were calanoid spiny eggs. In some cases (e.g., KASAHARA *et al.*, 1974) the spiny eggs were identified as resting stages of calanoid acartiids. In *Acartia latisetosa* the spiny eggs were of two types : with short spines (subitaneous), and with long spines (diapausal) (BELMONTE, 1970).

The hatched nauplii were easily identified as *Acartia* nauplii (SAZHINA, 1985). Those hatched from spiny eggs A and B of Fig.1 gave respectively *Acartia (Paracartia) latisetosa* (KRICZAGUIN) 1873, and *A. josephinae* CRISAFI 1976. For this last species this is the first description of the egg stage.

The egg density in the sediment diminished under the first cm (Fig.2) and in deeper layers the eggs with long spines were more abundant than in the surface layer. The chorion ornamentations are recorded also from other zoological groups (i.e., Rotifera and Tardigrada) which lay their eggs in the sediment. These structures probably favour the egg survival in the sediment keeping mud particles away from the egg surface and/or avoiding predation. Such ornamentations may be species-specific (e.g., among Tardigrada) and we think that more detailed morphological studies (e.g., at SEM) probably will allowe us to better identify also calanoid species.

It was not possible to correlate the egg position in the core with the age, e.g., the resting time of the eggs. For this purpose, some spiny egg from deeper layers of sediment were put under stressed conditions (4°C; in the dark) for 60 days. When these eggs were exposed to rearing conditions (21°C, 12hL:12hD) the most of them hatched after 1-20 days.

These resting eggs should restore the acartiid plankton populations in the Mar Piccolo once the adverse period ended. In fact this sediment "egg bank" holded up to 4,000,000 viable eggs per m^2 of sediment (within 5 cm of thickness), all potentially able to give nauplii.

The massive appearence of acartiids in some periods of the year and in some areas (swarms), and in general their population dynamics, must take in account the ecology of this "seed banks" (*sensu* ALLESSIO-LECK *et al.*, 1989).

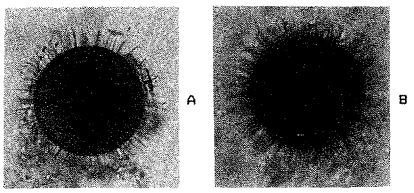
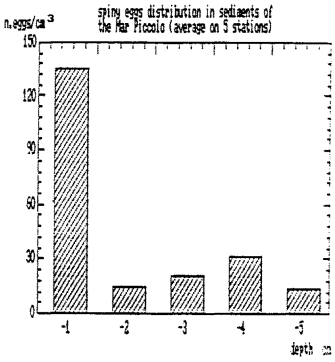


Fig.1 Spiny eggs.
A: Acartia latisetosa.
B: Acartia josephinae.

Fig.2



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Physiological responses of the copepod *Acartia Clausi* to Phenol

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Many authors have used marine zooplankton in acute or chronic toxicity tests. In particular there is a large literature concerning toxicity tests with copepods (see WELLS, 1984 for a review). Their sensitivity to toxic compounds is important because they are the main component of the zooplankton. A number of studies have addressed the question of how high concentrations of toxic substances affect juvenile stages (SULLIVAN and RITACCO, 1985). However, in the aquatic environment, pollutants occur at lower concentrations than those generally used for toxicity tests. For this reason, some authors observed response to sublethal toxicant doses, such as growth and mortality rates, and used these data to interprete chronic bioassays (ALLAN and DANIELS, 1982).

In our study, we chose the neritic calanoid copepod *Acartia clausi*, typical in Mediterranean coastal waters, for a toxicity test. The aim of this work was to control if reproductive rates, mortality and feeding activity were modified by exposing *A. clausi* females to phenol pollutant with respect to control populations. This compound was chosen because it is an ubiquitous environmental contaminant typical of many industrial wastes. Phenol is remarkably important as it is part of the production cycle of many chemical industries, in particular the oil industry. Many studies on acute toxicity have been conducted on fish, but only a few authors have analyzed phenol chronic toxicity on marine zooplankton and, in particular, on copepods (BUTTINO *et al.*, 1991).

We present here preliminary results of reproductive rates, feeding activity (expressed as fecal pellets production) and mortality rates of *A. clausi* females exposed to 500 µg/l phenol concentration.

Eighty adult females were collected in the Mar Grande in Taranto. Forty females were sorted individually in 60 ml crystallizers with 20 ml sea water filtered through a 45 µm mesh net and 30 ml of a mixture of food cells *Prorocentrum minimum* and *Phaeodactylum tricornutum* and forty females were taken in the same conditions but with phenol solution added to a final concentration of 500 µg/l.

Comparison among fiducial intervals (P=0.05) shows that there are not significant differences in reproductive rates between phenol-exposed females and control ones, until the eighth day (Fig.1A). Mean fecal pellet production showed lower values for phenol-exposed females only on the ninth and tenth day (Fig.1B). There were no differences between spawning and non-spawning females. *Acartia clausi* showed a great resistance to phenol as reported by KUYPER and HANSTVEIT in an *in situ* study (1984).

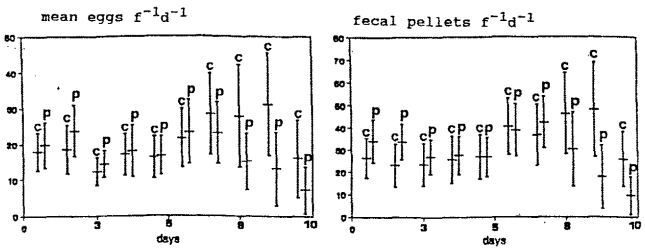

Fig.1 : Confidence intervals (95%) for phenol-exposed females (p) and control ones (c). A: Mean egg production rates; B: Mean fecal pellets production.

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Temporal variations of polyunsaturated fatty acids in particulate matter from a Ligurian Sea zone

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Particulate organic matter (POM) is a very important food source in both pelagic and benthic food chains. As previously reported (HUNTLEY *et al.*, 1987; LIBOREL HOUDE & ROMAN, 1987), the food quality greatly affects growth, reproduction and survival of zooplanktonic grazers and, after all, the whole marine food web (CARLI *et al.*, 1989; 1991); therefore, the evaluation of POM biochemical composition is extremely interesting because of its role in the marine environment.

Here we report results concerning the polyunsaturated fatty acid (PUFA) composition of POM during spring phytoplankton blooms, in a coastal zone of the Ligurian Sea.

Samplings were carried out in a station located within the Gulf of Spotorno-SV (sea bed - 50m); some researches carried out in this area showed lack of eutrophic phenomena (COTTA, 1992). On the whole, 32 samplings were collected during 1990 (26/2-19/7) and 16 during 1991 (14/2-13/6). To value the chlorophyll a concentration and the POM lipidic content were collected respectively 5 and 7 litres of sea water by an hand pump, to a depth of -10m. Sea water samples were filtered first with a 200 µm net, then with Whatman GF/C filters.

The chlorophyll a values were determined by spectrophotometric methods (STRICKLAND & PARSONS, 1968); lipid extraction was performed using a chloroform-methanol mixture (FOLCH *et al.*, 1957). After methylation (METCALFE & SCHMITS, 1961), the fatty acid composition was determined using a gas chromatograph (PERKIN-ELMER, SIGMA 3), equipped with a capillary column Supelcowax 10. The column temperature was maintained at 220°C.

During the two sampling periods changes of chlorophyll a concentrations were similar, ranging between 0.06 µg/l and 0.65 µg/l in 1990 and between 0.13 µg/l and 0.75 µg/l in 1991. During the first year, a phytoplankton bloom was recorded in April-May, while during the second year, two phytoplankton blooms occurred in March and May respectively (fig. 1).

During the examined periods the PUFA total percentages were low, accounting for 4.14% of total fatty acids in 1990 (minimum 1.8%; maximum 8.1%) and 6.46% in 1991 (minimum 2.9%; maximum 14.8%) on the average. By examining the PUFA percentage trend during the sampling periods (fig. 2 a-b), it can be noted that the maximum was recorded before the bloom start; a decrease followed subsequently. During the blooms, the PUFA percentages increased; maximum values followed the chlorophyll a peak.

The most abundant PUFA was C18:2 in both years; as for total fatty acids, C18:2 percentages (fig 2 a-b) reached maximum values in the pre-bloom period. The C18:2 percentage variations were not univocal during the various phytoplankton blooms. Among the other PUFA, C18:3, C18:4 and C20:5, generally found at low percentages, increased during the blooms; on the contrary, C22:6 percentage variations were not univocal during the various phytoplankton blooms.

As regards the lipid fraction, the nutritional value of POM greatly depends on its PUFA content. These fatty acids can be synthesized "ex novo" only by autotrophic organisms and are essential nutritional factors for animals (SARGENT & WHITTLE, 1981)

The PUFA percentage of the POM examined during this research was rather low in comparison with available data (KATTNER *et al.*, 1983; CLAUSTRE *et al.*, 1989; MAYZAUD *et al.*, 1989); it suggests that the analysed particulate matter be mainly composed by detritus, since PUFA decompose more rapidly than saturated fatty acids; perhaps this is due to the proximity of the sampling station to the coast line.

As regards the C18:2 prevalence over other PUFA, it can be noted (SARGENT *et al.*, 1987) that this fatty acid is a mayor constituent in blue-green algae, whereas is not abundant in Diatoms and Dinoflagellates; therefore it can be assumed a prevalence of blue-green algae within the phytoplanktonic biotic community in the examined area.

Variations of PUFA percentage showed that in the "pre-bloom" period the POM lipidic fraction had similar or greater qualitative value, altough occurring in lower amounts than during the blooms. The PUFA abundance of POM in the "pre-bloom" periods would exert an important role for consumers, representing a component of high nutritional value.

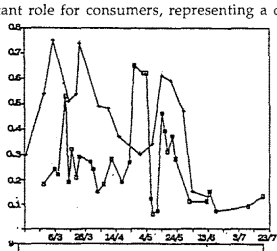

Fig. 1. Chlorophyll a concentrations (µg/l) recorded in the Gulf of Spotorno (SV). 5.3 - 19.7.1990 (□); 14.2 - 13.6.1991 (+).

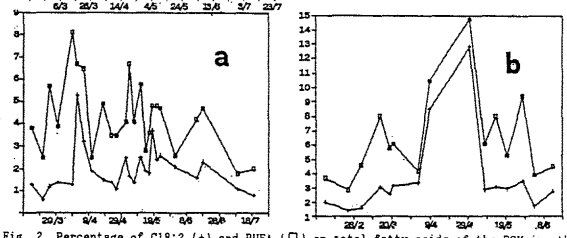

Fig. 2. Percentage of C18:2 (+) and PUFA (□) on total fatty acids of the POM in the Gulf of Spotorno (SV). a: 5.3 - 19.7.1990. b: 14.2 - 13.6.1991.

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Variations bathymétriques de la biomasse zooplanctonique au cours du nycthémère en Méditerranée Nord-Occidentale

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Les migrations verticales journalières du zooplancton, qui sont à l'origine de variations de biomasse importantes ont donné lieu à de nombreuses recherches mais peu sont relatives à des suivis précis de variations nycthémérales (FORWARD, 1988; SEGUIN, 1982; MORIOKA et KOMAKI, 1985; WEIKERT et TRINKAUS, 1990).

L'objectif de ce travail est l'étude simultanée à divers niveaux bathymétriques, de l'évolution des fluctuations de biomasse zooplanctonique au cours d'un cycle de prélèvement de 24 h consécutives. Ces recherches sur la cinétique des migrations verticales du zooplancton s'inscrivent dans le Programme national ECOMARGE relatif à l'écosystème planctonique de la marge continentale.

Les prélèvements ont été effectués sur les côtes du bassin nord occidental de la Méditerranée (42° 55' - 43° N; 5° 75' - 6° 5' E), au-dessus du canyon de Toulon et de fonds de 1200 à 1800 m au cours d'une journée et d'une nuit (11.30h, 13.30h, 17.45h, 19.30h, 21.15h, 23.00h, 1.00h, 2.30h, 5.00h, 6.45h, 8.30h, 10.00h) lors de la campagne CYAFLUX (8-18/10/1989).

Les variations d'éclairement au cours du nycthémère ont été mesurées à l'aide d'un photomètre à photomultiplicateur, celles de température et salinité à l'aide d'une bathysonde AANDERA. Les pêches ont été réalisées entre 0 et 1000 m à une vitesse de 2 noeuds, à l'aide de filets travaillant simultanément tous les 250 m. Ces filets, type Orinet modifié, (7 m de long, 2m² d' ouverture et 335 µ de vide de maille), sont munis d'une télécommande acoustique assurant leur ouverture et leur fermeture. Après chaque récolte, d'une durée de 15 à 20 min, le plancton est fixé avec du formol neutralisé au borax. Trois méthodes adaptées de celles de GRANDPERRIN et CABOCHE (1968) ont été utilisées pour mesurer les poids secs (mg), les poids humides (g) et les biovolumes (ml).

Les valeurs maximales de l'irradiance (3800 µW. cm^{-2}) se situent entre 11h et 13h locales, et les valeurs minimales (1,9. 10^{-3}µW. cm^{-2}) entre 18.45h et 23h. La thermocline se localise vers 25 m; à partir de 100 m, la diminution thermique est très faible. L'halocline se situe entre 50 m et 75 m; au-dessous, la salinité augmente progressivement. Les 3 techniques de mesure font apparaître des modalités de répartition similaires. Les biomasses ne sont pas très fortes puisque les maximums des biovolumes, poids humides et poids secs sont respectivement de 70 ml, 12 g et 1550 mg et leur schéma de répartition montre 2 maximums: l'un vers 17-18 h apparaît entre 200 et 300 m, l'autre vers 2h, entre 200 et 600 m. Les principales familles s'ordonnent comme suit.

La figure 1 illustre les variations nycthémérales et bathymétriques du poids sec au cours du cycle. En surface, les biomasses correspondant aux poids secs sont plus importantes que celles des poids humides ou biovolumes ce qui pourrait témoigner de migrations peu importantes chez les organismes gélatineux. Pour l'ensemble des pêches, et par ordre numérique décroissant on note les copepodes (76% du zooplancton), cladocères (19%), euphausiacés (2%), appendiculaires (1%), poissons (1%); viennent ensuite, en très faible quantité ptéropodes, siphonophores, isopodes et amphipodes.

Quelles que soient les heures de prélèvement, les biomasses les plus faibles sont trouvées au-dessous de 800 m, les plus élevées, entre 150 et 600 m. Pendant la journée les plus fortes densités planctoniques se situent dans la couche de relative homothermie. Pendant la nuit, on note deux maximums importants. Une migration des espèces profondes commence en fin d'après midi; elle se traduit par une biomasse élevée vers 200-300 m avant la tombée du jour. Au cours de cette migration quelques espèces seulement atteignent la couche ultrasuperficielle. Le maximum de biomasse, situé entre 150 et 600 m se produit en milieu de nuit; il peut correspondre à une deuxième ascension nocturne pour certains groupes et à une migration ascendante principale de beaucoup d'espèces à schéma de migration nocturne classique. En effet, vers minuit, parfois avant, de nombreuses espèces montent jusqu'au niveau de la thermocline, et certaines atteignent la surface où elles constituent l'hyponeuston nocturne (CHAMPALBERT, 1971; CHAMPALBERT et MACQUART-MOULIN, 1970; MACQUART-MOULIN, sous presse). Ainsi, la densité de la zone 200 - 400 m diminue et celle de la couche superficielle augmente. Une migration descendante importante a lieu avant la fin de la nuit. De plus, une diminution de biomasse importante survient après l'aube dans toute la colonne d'eau .

La zone prospectée au-dessus du Canyon de Toulon est moins riche que d'autres zones tempérées ou subtropicales (SEGUIN, 1982; MORIOKA et KOMAKHI, 1985). Toutefois, les résultats de la campagne CYAFLUX confirment certaines données bibliographiques, en particulier celles de PERES (1976) et de WEIKERT et TRINKAUS (1990) décrivant des répartitions analogues en Méditerranée.

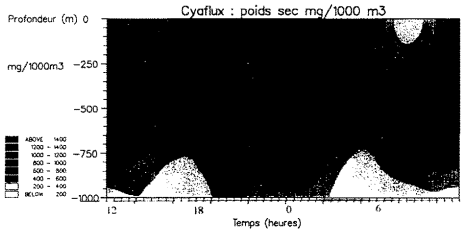

Figure 1 . Variations nycthémérales de biomasse: isolignes illustrant les fluctuations de poids sec aux différentes heures (abscisse) et profondeurs (ordonnée).

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Differentiation of the populations productivity parameters between two geographical strains of *Tisbe holothuriae*

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The marine copepod *Tisbe holothuriae* HUMES, which presents a widespread distribution in the coastal environment, is refered to in the literature as an appropriate organism for use as a live prey for young fish stages in aquaculture (KAHAN *et al.*, 1982).

In order to discern the most favourable conditions for mass culture of *Tisbe*, we have performed studies concerning the importance of various environmental factors on its population dynamics (MILIOU and MORAITOU-APOSTOLOPOULOU, 1991a, 1991b). In the present research we have comparatively studied the population dynamics of two greek strains of *T. holothuriae* to investigate if there are differences in the productivity of animals from different geographical areas.

Wild animals (G1) were collected: a) from the Aegean Sea (Saronikos Gulf) and b) from the Ionian Sea (Astakos Gulf). The culture conditions in the laboratory have been described in our previously mentioned papers.

The following parameters of population dynamics of *Tisbe* were measured and are shown in Table 1:

1) Time between the hatching of the egg sac G1 and the appearance of the first egg sac G2 (Development time).
2) Time between the appearance of the egg sac and its hatching (Maturation time of egg sac).
3) Time between the hatching of the last egg sac and the appearance of the next egg sac (Interval time between egg sacs).
4) Number of nauplii at the time of hatching (Number of offspring per egg sac).
5) Time between the appearance of G2 specimens and their death (Longevity).
6) Total offspring per female and their sex ratio.

The measurements of the mentioned parameters enables the determination of the demographic variables T, Ro, r_m, which allow for the prediction of the capacity of *Tisbe* for proliferation. The mean generation time (T) is defined as $T=\Sigma(x \cdot Ux)/\Sigma Ux$, where x is the age (in days) of females (G2) at the time of hatching of nauplii and Ux is the number of female nauplii per offspring. The Net reproductive rate Ro=G3/G2 indicates the replacement rate of ovigerous females (G2) by their female progeny (G3) from one generation to another. The Intrinsic rate of natural increase (r_m) results from the relation r_m=LnRo/T. The method applied to *Tisbe* population is given by GAUDY & GUERIN (1977).

Mean generation time does not show important differences between the two areas. High values of Net reproductive rate were noticed for the Aegean Sea population, but this was valid only for the G2 generation, while in G3 values dropped to slightly superior than those of the Ionian Sea population. Likewise, the Intrinsic rate of natural increase of the Aegean strain, which was significantly higher in the G2, dropped to values similar to the Ionian strain at the G3 level.

Because of the generally high values of measured parameters the Aegean population of *Tisbe holothuriae* seems more suitable for mass production, but due to the sharp decrease of these values in the G3 generation further investigations are needed for definitive conclusions.

Table 1. Mean values* of the parameters and the demographic variables of population dynamics of *Tisbe holothuriae* for the generations G2, G3 and for two geographical areas: A = Aegean Sea, I = Ionian Sea.
* (due to limitation of space standard deviations are not shown)

	Maturation time of egg sacs in days					Interval time between egg sacs in days				
No egg sac	1st	2nd	3rd	4th	5th	1-2	2-3	3-4	4-5	5-6
G2A	2.93	3.07	2.57	3.27	2.83	0.14	0.28	0.58	2.81	3.00
G2I	4.41	3.73	2.92	3.83	4.00	1.06	1.42	2.25	3.33	4.00
G3A	2.33	1.94	3.05	3.37	3.60	0.17	0.55	2.05	1.92	2.25
G3I	2.55	2.67	2.73	4.25	4.00	1.65	1.53	2.58	2.50	3.00

	Development time in days	Egg sacs per female	No of offspring per egg sac 1st	2nd	3rd	4th	5th
G2A	12.43	4.86	77.07	15.75	11.18	7.10	5.60
G2I	12.59	2.64	47.70	8.89	12.20	4.00	4.25
G3A	11.72	5.00	43.94	9.67	7.22	7.23	7.88
G3I	7.65	3.20	34.00	6.80	3.75	5.55	3.00

	Total adults per female	Longevity in days	Sex ratio (females)	T	Ro	r_m
G2A	83.90	30.78	51.89	15.89	36.84	0.23
G2I	15.81	31.28	47.70	17.75	10.37	0.13
G3A	32.27	25.68	45.35	14.43	14.63	0.19
G3I	23.00	24.10	43.87	12.92	10.09	0.17

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On the role of mesozooplankton in the regeneration of nutrients on the Saronikos Gulf (Greece)

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Among zooplankton excretions, special interest has been given to ammonia and inorganic phosphorus because of their importance as nutrients for phytoplankton. It is also well documented that ammonia is the major form of dissolved nitrogen excreted by zooplankton; in most cases the inorganic fraction of the dissolved phosphorus compounds dominates especially during low food conditions. Investigations of the mechanisms for nutrient regeneration are of primary importance in the study of productivity in the oligotrophic waters of Eastern Mediterranean.

This study was carried out fortnightly from January 1989 to January 1990. Living zooplankton were collected by oblique net (200 µm) tows from a shallow coastal area of the Inner Saronikos Gulf where the dominant species are the copepod *Acartia clausi* during winter and spring and the cladoceran *Penilia avirostris* during the warm period (CHRISTOU, 1992). Within two hours from the collection 7-8 subsamples of concentrated mixed zooplankton were introduced into 600ml beakers filled with filtered (GF/C glass fiber filters) sea water collected from the same area. For every two bottles there was one control (without animals) whereas all bottles (the controls and these with the incubated animals) were placed at *in situ* temperature and in darkness for 20-24 hours. Ammonia was determined after LIDDICOAT *et al.* (1975) and phosphates according to STRICKLAND and PARSONS (1972). Excretion rates (µg-at· µgdrwt^{-1} d^{-1}) were calculated from the difference between concentrations of test and control bottles. The daily zooplankton contribution to the nutrients was estimated taking into account the *in situ* zooplankton biomass (excretion rate x biomass).

The nutrient measurements in the study area showed that ammonia concentrations ranged from 0.16 to 1.25 µg-at· l^{-1} whereas the phosphate concentrations - fluctuated between 0 and 0.38 µg-at· l^{-1} were low for a coastal area especially during the summer months (Fig. 1 a). The daily ammonia excretion was calculated to range from negligible amounts to 0.049 µg-at· l^{-1} while the daily phosphates excretion was calculated to fluctuate from negligible levels just to µg-at· l^{-1} (Fig. 1 b). The excretion rates corresponding to ammonia and phosphates showed similar trends. The latter has also been found in the Western Mediterranean by ALCARAZ (1988). The higher values were recorded from June to October with a maximum in July while in the rest of the year extremely low values prevailed.

Estimates by many workers have shown that ammonia and phosphate excretions by zooplankton meet 40-90% of the nitrogen and 52-140% of the phosphorus demands of phytoplankton in various marine waters (IKEDA *et al.*, 1982). Thus zooplankton not only reduce phytoplankton biomass through their grazing activity but also contribute to phytoplankton growth. The nutrient cycling between phytoplankton and zooplankton is a possible mechanism for maintaining a high growth rate of phytoplankton in nutrient-poor waters (GOLDMAN *et al.*, 1979).

For the present study the daily zooplankton excretions seem to contribute a considerable amount for nutrients in the sea only during the warm period (Fig. 1). The daily ammonia excretion supplies 6.6% to the water column concentrations in July.

In this month, when phosphates were almost depleted from the sea, the phosphate excretion of zooplankton seems to be the only available source for phytoplankton.

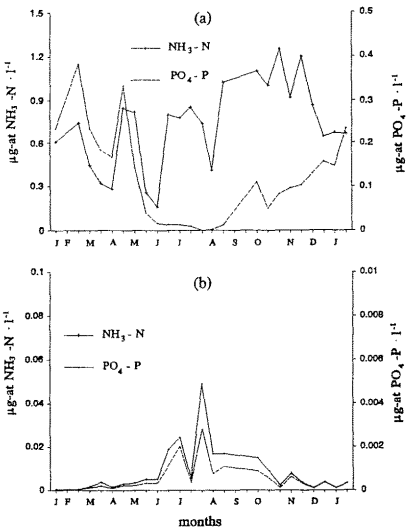

Figure 1. (a) Nutrient (ammonia, phosphates) fluctuations in the sampling area. (b) Daily mesozooplankton contribution to the nutrients through excretions for each sampling date.

In a Mediterranean lagoon (near Marseilles) the nitrogen excretion of zooplankton, attained higher va-lues in summer, represented a large percentage of the total water column stock and the nitrogen regeneration was considered as an important phenomenon (GAUDY, 1989).

Apparently the importance of zooplankton excretion as a nutrient regeneration mechanism varies from one system to another depending on the environmental conditions and contributions of other biological and non-biological nutrient supply mechanisms.

Although the study area is coastal with external nutrient enrichment sources, the phosphate excretion of zooplankton, particularly in summer, seems to be a significant nutrient regeneration process in the area. This point supports the hypothesis that in the Saronikos Gulf mainly phosphates limit the phytoplankton growth.

However for an overall consideration of the regenerated primary production in the area, the regeneration due to the bacterial activity upon faecal pellets and corpses as well as the microzooplankton contri-bution should be taken into account.

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Subduction des peuplements superficiels de copépodes pélagiques dans la convergence frontale de la Mer Ligure.

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Le front de mer Ligure sépare les eaux côtières (zone périphérique) des eaux marginales et centrales plus denses. On y observe des concentrations importantes de sels nutritifs dans la couche euphotique, accompagnées de maximums de biomasses phyto- et zooplanctoniques (PRIEUR, 1986, BOUCHER *et al.*, 1987, SOURNIA *et al.*, 1990). L'existence d'une circulation verticale secondaire impliquant un système de divergences et de convergences, permet un transfert rapide en profondeur de la matière organique produite en surface. La chlorophylle et ses produits de dégradation constituent des traceurs convenables des phénomènes de mélange ou d'entraînement qui affectent les eaux subsuperficielles. L'observation par NIVAL *et al.*, 1975, d'un second maximum chlorophyllien profond disposé parallèlement aux isopycnes qui plongent sous le courant Ligure a fourni une première évidence du transfert de la matière organique depuis la surface du front vers la côte en profondeur, en dessous du courant Ligure (subduction). Par comparaison avec un milieu océanique oligotrophe, des anomalies de répartition verticale de substances organiques particulaires et dissoutes (BARILLIER, 1988, MOMZIKOFF *et al.*, 1992), ainsi que d'indices du métabolisme plus actif des hétérotrophes microbiens de la zone aphotique (SAVENKOFF *et al.*, 1992), ont été interprétées en fonction de ce transfert. Ce phénomène lié au front, expliquerait aussi la présence à environ 400 m. de profondeur de populations denses de filtreurs macroplanctoniques (salpes et appendiculaires) qui utilisent le phytoplancton transféré rapidement depuis la zone euphotique (GORSKY *et al.*, 1991, LAVAL *et al.*, 1992). On constate aussi, en utilisant la détection acoustique pour localiser les peuplements nectoniques et macroplanctoniques, que la répartition en profondeur des couches diffusantes est très modifiée dans le front: les couches diffusantes intermédiaire et principale remontent de plus de 100 m dans les régions frontale et marginale où se produit un transfert descendant, -vertical ou oblique, de biomasse phytoplanctonique (BAUSSANT *et al.*, 1992). Comme ces couches sont attribuées à la présence de poissons planctonophages, ou d'autres carnivores comme les physonectes, on peut supposer que l'entraînement affecte aussi les organismes zooplanctoniques qui constituent leurs proies, principalement des copépodes. C'est cette hypothèse que nous avons voulu éprouver lors de la campagne Tomofront-1 (14-28 avril 1988, programme FRONTAL) au large de Villefranche-sur-Mer.

Le zooplancton a été récolté par un filet WP II triple (3 filets associés de 50, 200 et 500 µm de vide de maille) par traits verticaux fermants découpant la couche des 500 à 400 m en tranches successives. Les niveaux d'immersion maximale et de fermeture ont été choisis à bord en fonction de la répartition verticale locale de la fluorescence *in-vivo* de la chlorophylle 'a' (chl *a*) jusqu'à -200 m et, au-dessous, de la profondeur des couches diffusantes (BAUSSANT *et al.*, 1992). On a réalisé 34 pêches diurnes à 9 stations situées dans les 3 zones hydrologiques principales du front. Par ailleurs les caractéristiques physiques et chimiques (sels nutritifs. chl *a*, phaeopigments, matière organique dissoute et particulaire. ETS) ont été déterminées aux même stations par des mesures à la bathysonde ou après échantillonnage à la bouteille Niskin (BARILLIER, 1988).

Dans les échantillons obtenus avec le filet à maille de 2 µm le nombre des copépodes par m^3 décroît exponentiellement avec la profondeur moyenne des pêches. Cependant la répartition verticale des taxons principaux diffère beaucoup suivant les zones (Fig. 1). En zone marginale (station B14, à 26 milles nautiques de la côte) les copépodes sont concentrés dans la couche superficielle qui contient plus de 4,5 mg m^{-3} de chl a au pic. Ce contraste est moins accentué en zone périphérique plus oligotrophe (station B18 à 12 milles) et disparaît en zone frontale (station B17 à 14 milles) où des maximums subsuperficiels d'abondance de *Clausocalanus* spp. (qui représente près de 75% du nombre de copépodes), d'*Oithona* spp. et de *Centropages* spp. s'observent dans la colonne d'eau. Encore abondant en surface, *Calanus helgolandicus* y est aussi moins concentré. Les stations de la zone frontale contiennent des maximums secondaires de chlorophylle riche en phaeopigments, parfois supérieurs à 1 mg m^{-3}, situés entre 100 et 200 m, et qui traduisent l'influence de la convergence frontale. Les effectifs de *Clausocalanus*, *Oithona* et *Chelgolandicus* sont significativement corrélées à la concentration de chlorophylle totale dans l'ensemble des zones hydrologiques, y compris dans les tranches d'eau situées sous le maximum phytoplanctonique superficiel. Ce n'est pas le cas pour d'autres taxons abondants en surface comme *Centropages*. Manifestement le comportement des différentes espèces n'est pas identique vis-a-vis de la convergence. Ceci est en accord avec les conclusions de BOUCHER. 1984 et 1987, BOUCHER *et al.*, 1987 et IBANEZ et BOUCHER. 1987, sur la répartition différentielle des copépodes en surface à travers le gradient frontal. Bien que peu nombreuses et peu détaillées sur la verticale nos observations suggèrent que les populations (plurispécifiques) de *Clausocalanus* de *Centropages* et d'*Oithona*, sont passives vis-à-vis de l'entraînement en profondeur; une partie seulement des populations de *Calanus helgolandicus* subiraient le même sort.

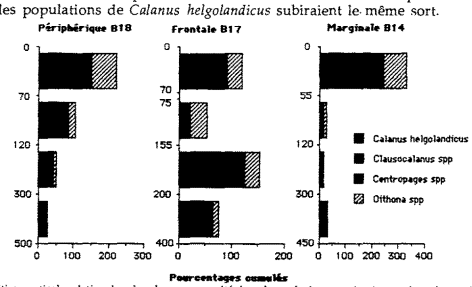

Fig. 1: Répartition verticale relative des abondances par unité de volume de 4 taxons dominants dans des stations typiques des 3 zones hydrologiques. Ordonnées: profondeurs extrêmes en m des tranches d'eau. Absisses: abondances relatives dans les tranches d'eau (pour chaque taxon le 100% est l'abondance, en nombre d'individus par m^{-3} d'eau filtrée. cumulée entre l'immersion maximale et la surface). La station frontale B17 comporte un maximum profond de chl *a* = 0,76 mg.m^{-3} à 180 m de profondeur, caractéristique de la convergence frontale.

La subduction d'une partie du peuplement de copépodes herbivores ou omnivores accompagnant le phytoplancton entraîné dans la zone aphotique est susceptible d'avoir d'importantes conséquences sur le devenir de la matière organique produite en surface dans les zones frontale et marginale. Nous pouvons supposer que le broûtage des copépodes se poursuit dans l'entraînement (bien qu'il n'existe pour l'instant aucune évidence directe de ce phénomène en dehors des teneurs non négligeables en phéorbides; (CLAUSTRE, communication personnelle), le phytoplanclon y restant en bon état physiologique (BRICAUT, communication personnelle). On peut donc conclure que la production nouvelle est efficacement exportée vers les niveaux trophiques supérieurs et n'est pas totalement dégradée dans la boucle microbienne, ou utilisée plus en profondeur par les filtreurs gélatineux mésopélagiques. L'influence du broutage des copépodes peut contribuer à la décroissance rapide de la biomasse chlorophyl-lienne dans la couche plongeante et à la régénération des sels nutritifs obsevée en zone frontale dans la partie supérieure de la zone aphotique (MOMZIKOFF *et al.*, 1992).

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Ichthyoplankton of the Egyptian Mediterranean waters.
VI- Distribution and abundance of Pilchard larvae.

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The occurrence and seasonal abundance of the pilchard larvae Sardina pilchardus (Walb.) in the southeastern Mediterranean waters off the Egyptian coast between El-Agami (long. 29° 45'E) and El-Arish (long. 33° 45'E) (Fig. 1), were studied from ichthyoplankton samples collected seasonally during the period from December 1981 to October 1984. The sampling methods and stations sampled are described in EL-RASHIDY & DOWIDAR (1990)

Results and Discussion.

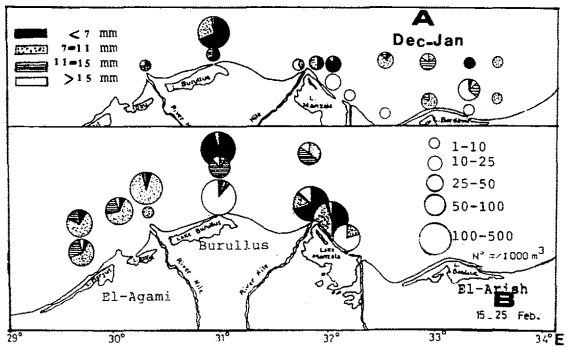
A total of 808 pilchard larvae ranging in size from 3 mm to 25 mm, were recorded in 127 ichthyoplankton samples collected from 93 stations in the study area during the period from autumn to spring.

Pilchard larvae first appeared in the plankton in late November when one specimen, 12 mm long, was recorded on 28 November in the middle zone (depth 55 m) indicating the beginning of the spawning season.

The spawning activity of the species increased progressively during the winter months, in late December-early January cruise. The larvae were widely scattered in the inshore zone from Rosetta to El-Arish (fig. 1), and ranged in length from 3 to 21 mm, the greatest density was found in the middle zone which harbored 74% of the larvae fished during this cruise, most of them (63%) were of smaller size (< 11 mm) (Table 1).

The spawning activity of S.pilchardus in the area, reached its peak in February, when 75% of the total larvae fished were recorded from 80% of the stations sampled, ranging in length between 3 mm and 25 mm (Table 1). The water temperature during this month reached its annual minimum (16-18°C) and conditions of homothermal and homohaline water column exists. Most of the larvae, i.e. 67%, occurred in the inshore zone (Table 1).

In April (15-26 IV), the larvae were scarce, 7 specimens (with length range 13-23 mm), were irregularly dispersed in the inshore and middle zone. The absence of smaller larvae probably reflects the low spawning activity in late March and end of spawning season in April.



Unfortunately, data on the reproductive biology of pilchard in our waters are completely lacking. However, as in other Mediterranean regions, the present results showed that this species is a true winter spawner. The breeding season extends from mid-November to April with the peak in February. The observed breeding temperature ranged from 16°C to 21. 5°C and the salinity range 37.6-39.7%. . These results corroborate those given for this species in other Mediterranean regions, where the reported breeding temperature ranges between 8 and 23°C and salinity 23-38.8%; the temperature range of the adult fish 8 to 28°C (DEMIR and DEMIR, 1961; ZAVODNIK, 1970).

As to the spawning grounds, it is generally believed that the species breeds in deeper waters, 40-90 m (FISHER, 1973; YANNOPOULOS and YANNOPOULOS, 1979). In the Egyptian Mediterranean waters, newly hatched larvae occur in both inshore (20-30 m depth) and middle-offshore (50-150 m) zones (fig 1). CIHANGIR (1990) reported that hatching of Pilchard larvae require 2-3 days at 16-19°C. It is thus obvious that spawning of the species occur in both inshore and middle offshore zones. Whether this pattern reflects the presence of two stocks of adult fish, a local endemic stock spawning in the inshore zone, and a migratory stock invading the area in early winter for spawning and feeding could not be revealed with certainty from the present results.

Whether the fish spawn in surface or subsurface waters is not easy to clarify from available data. However, during the December cruise, about 50% of the pilchard larvae caught occurred in subsurface waters (20-25 m) most of them were of smaller size (3-7 mm) indicating that spawning may occur in subsurface layers (DEMIR and DEMIR, 1961).

Table (1) : Percentage occurrence of the different size groups of Pilchard larvae in the study area (based on the actual numbers in each sample).

Cruise	Zone	3.1-7 mm %	7.1-11 mm %	11.1-15 mm %	15.1-19 mm %	> 19 mm %	Total %
Dec-Jan. (22/12/81-4/1/82)	Inshore	5.3	5.3	2.4	2.8	4.3	20.1
	Middle	40.7	22.0	3.8	6.2	0.96	73.7
	Offshore	0.5	1.4	3.3	0.96	NR	6.2
February (15-25/2/84)	Inshore	23.3	14.2	1.0	16.6	11.7	66.8
	Middle	0.7	13.4	5.6	0.7	NR	20.3
	Offshore	6.9	3.9	1.7	0.34	NR	12.9
April (15-26/4/82)	Inshore	NR	NR	14.3	NR	42.8	57.1
	Middle	NR	NR	--	42.8	NR	42.8
	Offshore	--	--	--	--	--	--

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Ichthyoplankton of the egyptian Mediterranean waters
V. Distribution and abundance of larvae of *Sardinella aurita*, Valen

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The distribution and abundance of the larvae of *Sardinella aurita*, valen. in the Mediterranean waters overlying the continental shelf off the Egyptian coast (Fig. 1) were studied seasonally during the period from December 1981 to October 1984. The study area, stations sampled, sampling methods were previously described by EL-RASHIDY & DOWIDAR (1990).

RESULTS & DISCUSSION

A total of 863 larvae of *S. aurita* were recorded in the ichthyoplankton samples collected during the warm months from July to October. The larvae were completely absent in other months. The length of the recorded larvae ranged between 3 and 21 mm.The larvae of *S. aurita* first appeared in the plankton samples collected during the first half of July when a total of 88 larvae were recorded, 75% of them occurred in the offshore station off Burullus (Fig. 1A). The recorded larvae covered the length range 3 to 19 mm, but most of them (60%) had length from 7 to 11 mm (Table 1). Assuming the same rate of growth given by OLIVER & NAVARRO (1952) the older larvae caught during this cruise were probably spawned around mid June.

In late July - early August cruise, the larval density was low and mostly concentrated in the inshore, (< 50m) depth and middle zones (Fig. 1A) and ranged in length from 3 to 13 mm (Table 1).

The larval density of *S. aurita* reached its peak during the second half of August when about 88% (758) of the larvae fished in all cruises were recorded (Fig. 1C) ranging in length from 3 to 21 mm. The majority of them (77%) had lengths between 5 and 15mm (Table 1). As shown in Fig. 1C, 92% of the sampled larvae occurred in the inshore zone. From late July throughout August the larvae were not recorded in the offshore zone. In early October only 2 specimens 10 and 15 mm were recorded from the inshore waters off El Agami and probably reflecting the end of the spawning season.

The present pattern of larval occurrence and abundance, clearly demonstrates that *S. aurita* is a typical summer breeder. The spawning season mostly begins in June, reaches its peak in late August and ends in October. The temperature range recorded during this period varied between 21°-29.5°C. These results generally conform with those reported by other authors working on the reproductive biology of the species.(BEN-TUVIA, 1960; EL-MAGHRABY, 1960).

Concerning the spawning grounds of *S. aurita*, it is believed that the final stage in gonad maturation takes place in the spawning grounds away from the coast (EL-MAGHRABY, 1960). This may explain, at least partly, the abundance of larvae (311 mm) in the offshore zone at the beginning of the spawning season. According to the local current regime, it is more probable that these larvae belong to an offshore stock which perform regular migrations to the coastal region off the Nile Delta during this period. On the other hand during the peak of larval occurrence most of the larvae occurred in the coastal waters and none occurred in the offshore waters. This picture may substantiate the suggestion that the populations of *S. aurita* present in the Egyptian Mediterranean waters are composed of two stocks, an endemic stock widely distributed in the coastal waters (< 50 m depth) all the year round and which spawns throughout the period from June to early October with a peak in August, and a migratory stock from the offshore waters that invades the area for feeding and spawning. The high larval density recorded at the offshore station off Burullus in early July would suggest that, this area acts as a suitable breeding ground for the species.

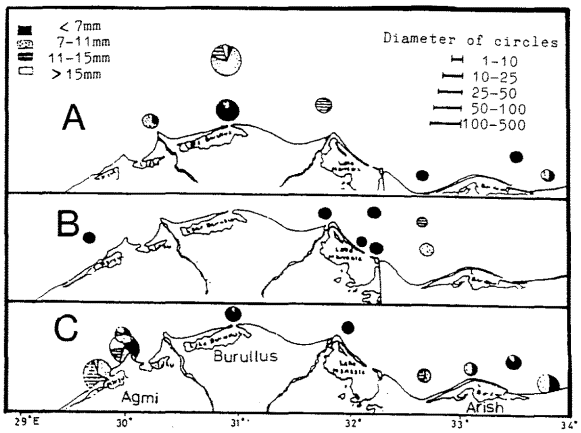

Fig.1. Distribution and abundance of different size groups of *S. aurita* larvae in the inshore, middle and offshore zones in the study area during (A) July, (B) July-August, and (C) August cruises.

Table 1. Occurence of the different size groups (mm) of *S. aurita* larvae in the inshore, middle and offshore zones of the study area.

Cruise	Zone	3.1-7	7.1-11	11.1-15	15.1-19	>19	Total
6-18 July 84	Inshore	13.6%	3.4%	1.1%	NR	NR	18.2%
	Middle	2.3%	NR	4.5%	NR	NR	6.8%
	Offshore	4.5%	56.8%	11.4%	2.3%	NR	75.0%
28/7-4/8/83	Inshore	46.7%	6.7%	NR	NR	NR	53.3%
	Middle	40.0%	NR	6.7%	NR	NR	46.7%
17-25 August 82	Inshore	24.8%	24.0%	32.4%	10.4%	0.4%	92.1%
	Middle	4.1%	2.5%	0.6%	0.6%	NR	7.9%

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Zooplankton distribution and water masses influence in the Ibiza Channel (Baleares Islands)

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A qualitative and quantitative study has been made on the spatial distribution of the zooplankton community associated with the special hydrographic characteristics in the area between the Iberian Peninsula and Ibiza Island.

Two oceanographic surveys were carried out, each of six days duration, the first in November 1990 and the second in March 1991. Twelve hydrographic and biological stations with 10 miles apart were established. The zooplanktonic samples were collected by oblique tows from a 100 m depth to the surface , using 20 cm O Bongo nets, equipped with a 250 µm mesh and a General Oceanic flowmeter.

In both months the distribution of zooplankton observed, biomass and structure, was totally different and in accordance with the hydrographic conditions found in the area (2).

The November survey with 2.25 ± 0.48 mg D.W./m^3 (72% O.M.) and 178 ± 18 ind/m^3 (70% copepods) indicates the influence of the cyclonic eddy in the center of the channel on the zooplankton communities by dispersing the layer organisms towards the edge while the smaller individuals remain accumulated in the centre of the channel (Fig. 1).

In the March survey, the situation was not so clearly defined because of the flowes of the cyclonic and anticyclonic eddies that appeared along the NE-SW axes of the work area (op.cit.); nevertheless the higher zooplanktonic biomass observed was along that direction, especially in the SW of the channel. In this occasion, the biomass average was 8.72 ± 2.48 mg D.W./m^3 (57% O.M.) with 398 ± 85 ind/m^3 (78% copepods). The biggest organisms present in the community studied, (siphonophores, salpids or appendicularians) were mostly found in the edge of the area analyzed, and close to the anticyclonic eddy (Fig. 2).

Summing up, we can assume that in both cases the mesoscale studies allow us to observe the complexity of the hydrodynamics of the water, and its high stational variability. Although we do not know much about the persistence of the phenomenon, the presence of the fronts and eddies act as fertility mechanisms (1) where the zooplankton reveals the amplifying character of the physical processes in the area.

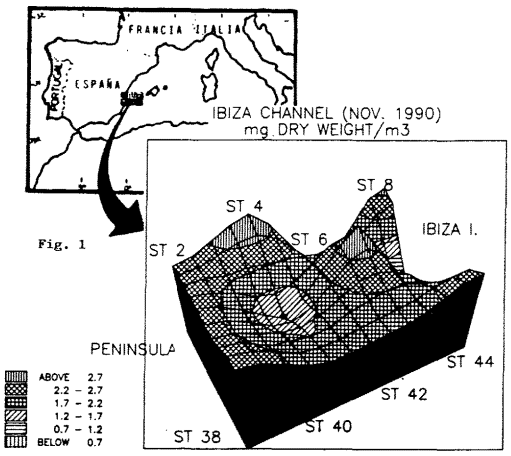

Fig. 1

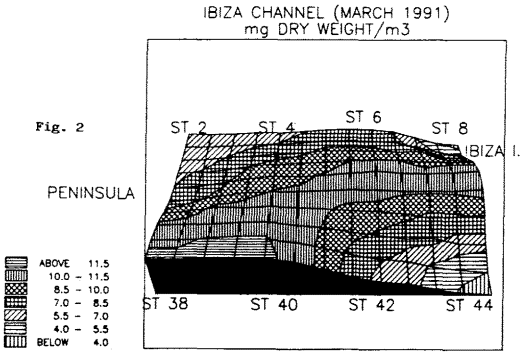

Fig. 2

Fig. 1: Zooplankton distribution (as biomass) in Nov. 1990.

Fig. 2: Zooplankton distribution (as biomass) in March 1991.

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Ultrastructure de l'endostyle des salpes

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Summary : The endostyle of the Salps is a glandular and ciliary groove lining the floor of the branchial cavity. The ciliary epithelium is less developed. The glandular cells display a densely packed, and in some cells very regular, rough endoplasmic reticulum, the presence of which supports the view of a synthesis of proteins, probably digestive enzymes as in the ascidians.

L'endostyle des prochordés, Tuniciers et Amphioxus, d'abord considérée comme un épithélium simple, cilié et glandulaire dont le mucus assure la capture des microparticules alimentaires, s'est révélée être aussi un précurseur de la thyroïde et un organe capable de produire des enzymes digestives (GODEAUX, 1989, *Bull. mar. Science* 45 (2): 228-242 - Bibliographie).

Chez les Salpes *(Thalia democratica)*, l'endostyle offre en coupe transversale (fig. 1) l'aspect habituel d'une rainure dont le fond est occupé par une zone médiane flagellée (A) et dont les parois sont constituées de plusieurs bandelettes glandulaires (B, D, F) bien développées et d'une zone ciliée (C).

La zone A n'a qu'une cellule de largeur avec 3 rangées de très longs flagelles sans microvillosités et à racines plongeant dans un cytoplasme dense riche en mitochondries de grande taille. Il n'y a pas trace de sécrétions. Les flagelles atteignent les bords de la rainure. Le noyau volumineux est rejeté à la base de la cellule. Comme au niveau des autres cellules, le cadre unissant est bien marqué.

Les bandelettes B et D se composent de cellules géantes à noyau basilaire volumineux (polyploïde ?) et à nucléole bien coloré. Elles se caractérisent par un ergastoplasme granuleux dense et d'une très grande régularité, parsemé de mitochondries volumineuses parfois accolées au noyau. L'appareil de Golgi est présent. Le sommet de la cellule est occupé par les grains de sécrétion. La base des cellules B principalement est largement en contact avec la membrane basale. Dans le cas de la partie supérieure de D (D_2), les cellules sont enroulées en un cercle presque complet (révélé par la position des noyaux); les grains de sécrétion intravacuolaires sont concentrés sur un axe diamétral dont le sommet est occupé par un bouquet de flagelles entourés de microvillosités (fig. 2). Les cellules B sont en général dépourvues de flagelles, les cellules D_1 ont des flagelles sans microvillosités insérés obliquement vers le haut. Comme dans les autres endostyles, une cellule B' d'apparition précoce et à fonction inconnue est coincée entre les sommets des cellules A et B voisines.

La zone C est formée de cellules flagellées hautes et étroites, disposées en un épithélium pseudostratifié; les noyaux volumineux et dépourvus de nucléole sont pressés les uns contre les autres. Le cytoplasme est réduit à une lame. Les racines ciliaires sont horizontales et s'insèrent au niveau du cadre unissant. Il n'y a ni de grains de sécrétion, ni microvillosités.

La zone ciliée médiane (E) présente chez les Ascidies, paraît faire défaut et à la bandelette D_2 fait suite un épithélium glandulaire de hauteur progressivement décroissante vers les lèvres de l'endostyle.

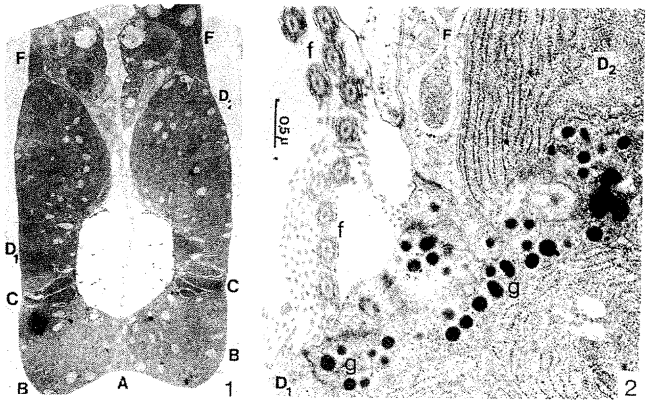

Fig. 1: c. tr. endostyle. Fig. 2: détail de la bandelette D (f: flagelles, g: grains de sécrétion).

Les cellules de cet épithélium (F) présentent un ergastoplasme très dense, mais d'aspect enchevêtré. Leur noyau arrondi est rejeté vers la périphérie. De grandes mitochondries sont visibles. Des grains de sécrétion sont rangés le long de la paroi supérieure des cellules. Dans certains cas, la transition entre D_2 et F est assurée par une cellule à cytoplasme clair et à ergastoplasme régulier, mais peu fourni. Cette cellule a été entraînée vers le bas de l'organe par l'enroulement de D_2.

Les lèvres de l'endostyle sont occupées par des cellules ciliées répondant à la bande ciliaire supérieure des Ascidiacés. Au delà, l'épithélium de l'endostyle se continue dans la paroi pharyngienne.

L'endostyle de *Salpa fusiformis* est très semblable.

La structure générale de l'organe paraît plus simple que chez les Ascidies. En effet, ce qui caractérise l'endostyle des Salpes est la dominance de la partie glandulaire et la réduction parallèle de la partie ciliée. Existe-t-il une relation avec l'absence d'un système branchial réduit à une fente protostigmatique de part et d'autre de la barre branchiale ? Les cellules répondant à la partie apicale de l'endostyle des Ascidies où s'opère la synthèse des dérivés iodés décelés pourtant chez les salpes, n'ont pas été identifiées.

Chez les Ascidies, également phytophages, l'endostyle secrète principalement des β D glycosidases, peu d'α glycosidases (à l'exception de l'α D mannosidase et surtout de l'α L fucosidase) et des enzymes protéolytiques.

Distribution du zooplancton fragile dans la colonne d'eau étudiée à l'aide d'un Profileur Vidéo Marin

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La matière organique produite dans la zone euphotique est d'une part recyclée dans les couches superficielles, d'autre part exportée vers les couches profondes. Cette dernière est soumise aux processus d'agrégation, de dispersion et de reagrégation dans la colonne d'eau. Elle constitue alors un substrat propice au développement de réseaux trophiques particuliers (ALLDREDGE et SILVER, 1988). Nous connaissons peu les processus de dégradation. L'activité bactérienne peut augmenter la valeur nutritive de ces agrégats en diminuant le rapport C/N et en les rendant digestibles ou recyclables. La reagrégation des particules organiques par des filtreurs peut catalyser cette activité bactérienne (GORSKY *et al.*, 1991). De rares observations à partir de submersibles ont signalé la présence de fortes concentrations d'organismes gélatineux dans des couches mésopélagiques, mais les systèmes conventionnels d'échantillonnage ne sont pas adaptés à leur récolte.

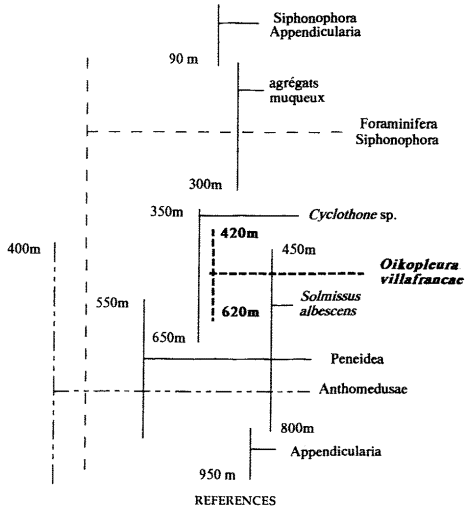
C'est pour l'étude de la distribution verticale et horizontale des organismes fragiles ainsi que des particules organiques en suspension que nous avons mis au point un système submersible appelé "Profileur Vidéo Marin". Ce système a été utilisé avec succès lors de la campagne Almofront 1, consacrée à l'étude de la zone frontale Almeria-Oran en Méditerranée occidentale et lors du programme de prospection des populations méso- et bathypélagiques de la zone frontale liguro-provençale (MBP-Front).

Le Profileur Vidéo est composé de: 1- Une source d'énergie surdimensionnée, se composant de batteries de plomb en équipression. 2- Deux systèmes d'éclairage étanches: le premier délivrant un faisceau paral-lépipédique qui éclaire les particules en suspension dans un volume connu, le deuxième se compose de quatre sources lumineuses éclairant un grand volume d'eau pour la reconnaissance des organismes en suspension. 3- Un camescope vidéo piloté par un microprocesseur placé dans un boîtier étanche enregistrant perpendiculairement à la source de lumière une partie du volume d'eau éclairé. L'ensemble peut être programmé pour le déclenchement et arrêt de l'enregistrement à une profondeur, température ou heure données. 4- Un système de dépouillement, se composant d'un magnétoscope et d'un ordinateur muni d'une carte d'acquisition d'images ainsi que d'un logiciel de traitement d'images (pour plus de détails voir GORSKY *et al.*, sous presse).

La vitesse d'immersion est de 0,50 m s^{-1} et le poids de l'appareil à sec est de 160 kg. Un sondeur CTD fixé sur le bâti fournit les données environnementales. Nous nous focaliserons ici sur la description de la distribution verticale, de 50 à 950 m, des organismes macroplanctoniques caractéristiques de la colonne d'eau des deux côtés du front liguro-provençal. Les dépouillements des séquences filmées durant les immersions effectuées les 24 et 26 juin 1991 à 8 miles et à 28 miles de St. Jean Cap Ferrat à 13 heures (heure locale) montrent que d'une part la quantité de particules en suspension dans la colonne d'eau visualisée par le Profileur est beaucoup plus élevée près des côtes qu'au large et d'autre part le maximum observé entre 400 et 500 m à 8 miles n'existe pas à la station du large. Associée à ce maximum intermédiaire se trouve une nouvelle espèce d'appendiculaire *Oikopleura villafrancae* Fenaux 1992 (FENAUX, sous presse). Aux deux stations, on observe un maximum profond en concentration de particules vers 750-800 m. Ce maximum est caractérisé par la présence d'une ou plusieurs espèces d'appendiculaires, collectées par les submersibles et en cours de détermination. Aux deux stations les amas et les filaments muqueux ont été nombreux entre 90 et 300 m de profondeur environ. Des siphonophores et des protistes foraminifères ou radiolaires ont été présents dans toute la colonne d'eau. Des cténophores lobés et des petites anthoméduses devenaient fréquents à partir de 400 m. Des poissons mésopélagiques, les *Cyclothone* sp., ont été décelés à partir de 350 m, les méduses *Solmissus albescens* et les euphausiacés à partir de 450 m à la côte et à partir de 550 m au large. Les décapodes penaeidés ont été observés souvent vers 700 m de profondeur. Au delà de 850 m, nous avons noté la présence d'appendiculaires, de cténophores lobés, de siphonophores et de radiolaires ou foraminifères. Cette liste n'est pas exhaustive, et la détermination des espèces à partir du support vidéo n'est que provisoire. Il est en effet important de capturer les organismes filmés pour les déterminer précisement. Nous avons tenté d'effectuer cette approche en 1991 en Méditerranée, lors d'une campagne océanographique franco-américaine en utilisant le submersible Johnson Sea Link. Les résultats sont en cours de dépouillement.

D'après les premiers résultats obtenus par le Profileur Vidéo Marin, on peut noter que : 1 - la station du large est plus pauvre en biomasse que la station côtière et 2 - les appendiculaires mésopélagiques *O. villafrancae* sont absents à la station du large. Leur présence à la station côtière peut être attribuée au transfert oblique de la matière en profondeur, qui est une des caractérisques d'un front géostrophique (SOURNIA *et al.*, 1991). Ci-dessous le schéma de la distribution verticale, de jour, des organismes macrozooplanctoniques catactéristiques de la colonne d'eau, établi d'après les enregistrements du Profileur Vidéo Marin.

Distribution verticale du Macrozooplancton



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Liriope tetraphylla (Cnidaria, Hydromedusae) en Mer Ligure

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Depuis la révision de KRAMP (1961), il est désormais acquis qu'une seule et même espèce de *Liriope tetraphylla* (CHAMISSO and EYSENHARDT, 1821)est distribuée dans toutes les parties tempérées et chaudes des trois océans. En Méditerranée, elle est très commune, elle est citée dans tous les inventaires de la faune de méduses où sa présence constante en fait un élément important dans l'écosystème pélagique gélatineux (GOY, 1972).

Depuis 20 ans, elle a été étudiée en Mer Ligure, tout particulièrement en 1963-1964 et 1986-1988, en divers points de la rade de Villefranche-sur-Mer et plus au large jusqu'en Corse avec des pêches horizontales et verticales par paliers.

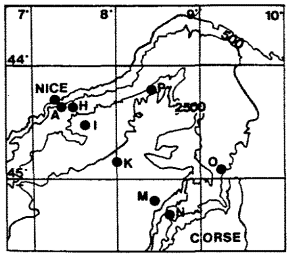

Fig. 1 - Station en Mer Ligure

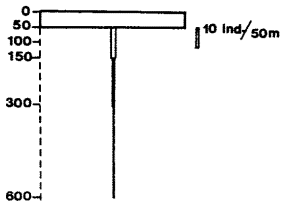

Fig. 2 - Bathymétire des individus

I- L'analyse de tous ces prélèvements montre que les individus sont concentrés :

1° : dans la veine d'eau côtière, ils ne dépassent pas la limite du front liguro-provençal (Fig. 1) avec une forte densité de la côte

2° : dans la couche d'eau superficielle où plus de 90% des individus sont récoltés quelque soit la période de l'année, l'espèce est donc épipélagique (Fig. 2);

3° : dans la période de mai à septembre qui correspond au réchauffement de la couche supérieure nettement individualisée des couches sous-jacentes par l'installation d'une thermocline. L'espèce ne disparaît jamais, cependant un fort maximum se dessine pendant cette période chaude avec des densités qui passent de 4 ind./m3 à plus de 200 ind./m3 dans la rade.

II- La mesure du diamètre des individus récoltés au cours d'une année montre que les plus grands individus apparaissent en mai (Fig.3).

III- L'analyse démographique est intéressante. Les quatre stades de développement définis par RUSSELL (1953) ont été analysés dans toutes les pêches. La population de la Mer Ligure montre que la reproduction s'étale sur toute la période chaude avec un nombre élevé de juvéniles. Les adultes de la fin de l'été semblent survivre à l'homothermie froide en continuant leur croissance, d'où la grande taille des spécimens du mois de mai, et l'augmentation de la température semble un élément favorable au déclenchement de la reproduction (Fig. 4), alors que BERHAUT (1968) la signale en automne. Néanmoins, il est encore difficile de préciser le nombre de générations par an.

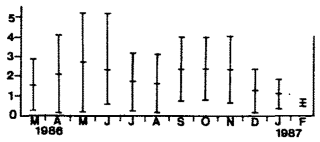

Fig. 3 : Variations mensuelles du diamètre

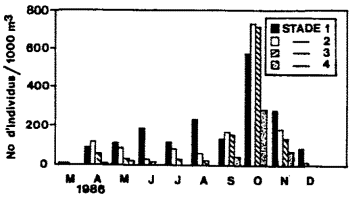

Fig. 4 : Répartition annuelle des 4 stades

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P

The effect of food quality on egg production and hatching success in the copepod *Acartia clausi*

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Food quality is known to be a major factor affecting egg production rates in marine planktonic copepods. Some diets are better than others for determining higher fertility in copepods (1970) with some diets such as *Phaeocystis* suppressing egg production alltogether. Recent studies suggest that food quality can also affect egg viability whereby viable eggs are defined as fertilized eggs that develop to hatching giving rise to a living nauplius (IANORA and POULET, submtd.). The object of this study was to determine the effect of different algal diets on egg production rates and hatching success in the coastal copepod *Acartia clausi*. Forty-six adult females were collected on different sampling occasions from January to December 1991 in Taranto (Italy) coastal water. In a first set of 23 experiments females were sorted and kept individually in containers with 100 ml of 0.45 um filtered seawater enriched with 5 ml of laboratory cultured diatom *Thalassiosira rotula* given in excess concentrations from 5.6 x 10^4 to 15.4 x 10^5 cells l^{-1}. Egg productionand faecal pellet production were determined daily and females were then transferred to new containers with fresh media. To avoid disturbing eggs during their development, we avoided their transfer to new containers and determined egg viability in original containers after 72h. In a second set of 23 experiments the same variables were monitored daily for females kept with the laboratory-cultured dinoflagellate *Prorocentrum minimum* given in excess concentrations from 3.8 x 10^4 to 1.4 x 10^5 cells l^{-1}. Mean female longevity was about 25-30 days with some females that lived up to 70 days under these experimental conditions. Egg production was higher in *P. minimum* diets (mean *P. minimum* = 17.3 eggs f^{-1} d^{-1}; mean *T. rotula* = 8.4 eggs f^{-1} d^{-1}). Egg viability was also much higher with *Prorocentrum* (mean *P. minimum* = 61 % ; mean *T. rotula* = 23 %) (Fig.1). In fact, we rarely observed 100% egg viability with *Thalassiosira*. Both groups of females produced viable eggs for up to 30-35 days suggesting that this species does not need to remate as often as others (PARRISH and WILSON, 1978; IANORA *et al.*, 1989). These results confirm those of IANORA and POULET (submtd) that food type stongly influences hatching success. These authors showed that *Prorocentrum* was a more nutritious food than *Thalassiosira* for the production of good quality eggs in *Temora stylifera* since it contained higher quantities of proteins, vitamin C, carbon and nitrogen.

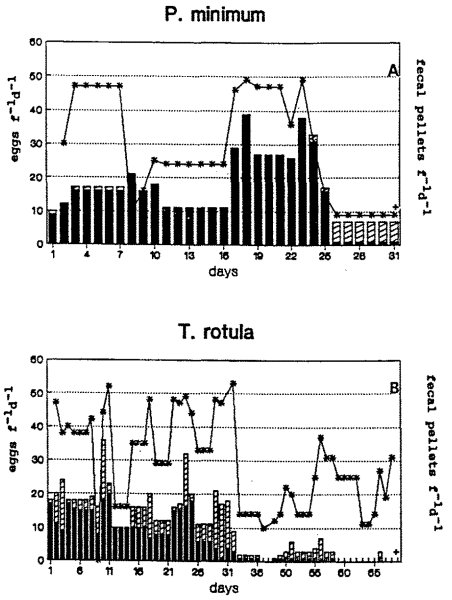

Fig. 1 Daily eggs production, viability and fecal pellets for *Acartia clausi* fed (A) *P. minimum* and (B) *T. rotula*.

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Intérêt trophique des bactéries photosynthétiques sulfo-oxydantes pour l'élevage de jeunes stades d'invertébrés marins.

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Dans les étangs littoraux du Sud de la France, le développement printanier et estival d'algues vertes, notamment des Ulves, provoque souvent au moment des plus fortes chaleurs un phénomène de dystrophie. L'anaérobiose qui règne alors cause la mort de la plupart des invertébrés et permet le développement de bactéries réduisant les composés soufrés, avec formation de sulfures sous forme d'hydrogène sulfuré. Dans une seconde étape, des bactéries sulfo-oxydantes utilisent l'hydrogène sulfuré et restaurent peu à peu le milieu dans lequel de nouvelles populations se développent rapidement, en particulier un harpacticoïde appartenant au genre *Tisbe*. Ces phénomènes de dystrophie ont été décrits par AMANIEU *et al.*, (1975) pour l'aspect biologique et hydrologique et par CAUMETTE et BALEUX (1980) pour l'aspect bactériologique.

Il était intéressant d'essayer de produire en milieu artificiel ces bactéries sulfo-oxydantes et de tester leur rôle trophique vis-à-vis de jeunes invertébrés:
- une annélide polychète, *Malacoceros fuliginosus*,
- un bivalve, *Cardium glaucum*.

Matériel et méthodes

Production de bactéries.

Les bactéries sont produites dans une cuve de 500 l maintenue à l'air libre et exposée à la lumière naturelle, remplie de 400 l d'eau de mer diluée (30°/) et contenant environ 50 kg d'Ulves. Celles-ci ont séjourné au préalable pendant au moins un mois dans une cuve annexe, où, tassées et recouvertes d'eau, elles ont pu être partiellement dégradées par les bactéries réductrices. Après quelques semaines, la grande cuve prend une couleur rouge magenta qui témoigne de la présence de bactéries photosynthétiques, sulfo-oxydantes anaérobies. Celles-ci appartiennent en grande majorité au genre *Chromatium* accompagnées par quelques *Thiovulum* (détermination par P. CAUMETTE et R. MATHERON). Il suffit d'ajouter de temps en temps de l'eau de mer et des Ulves pour maintenir la production de la cuve à son niveau maximum pendant plusieurs années.

Utilisation des bactéries.

L'eau riche en bactéries est prélevée au moyen d'un siphon; elle est centrifugée (10 min, 6000 RPM); le culot de centrifugation est congelé. On peut ainsi constituer un stock important et homogène de bactéries permettant d'effectuer des expériences à long terme. Ces bactéries sont fournies aux animaux à raison de quelques dizaines de µl par l.

Résultats et discussion

Avec les larves de *Malacoceros fuliginosus*, les premières métamorphoses ont été obtenues après 9 j d'élevage; le taux de survie est de 95% en moyenne. Ces résultats sont parmi les meilleurs qui ont été obtenus au cours des multiples expériences réalisées depuis que cette espèce est élevée en cycle complet (GUERIN, 1987).

Avec le bivalve *Cardium glaucum*, l'élevage de larves âgées récoltées dans le plancton et nourries exclusivement avec cette communauté bactérienne a permis d'obtenir la métamorphose puis la croissance des jeunes stades benthiques. Cette croissance a été rapide puisque l'on est passé d'une taille moyenne de 0,5 mm à une taille de 9 mm en 100 j, soit un accroissement journalier moyen de 0,085 mm.

Après ce délai, certains lots de ces bivalves se sont reproduits spontanément, à un âge approximatif de 135 j. L'obtention de la maturité sexuelle prouve que les communautés bactériennes utilisées comme nourriture sont susceptibles de couvrir tous les besoins alimentaires de ces bivalves.

Cependant, il convient d'être prudent dans cette interprétation. En effet, de très jeunes bivalves récoltés dans le milieu naturel et nourris avec ces communautés bactériennes voient leur glande digestive prendre une couleur rouge intense en 10-15 min: ceci prouve que la branchie est susceptible de retenir les cellules bactériennes; c'est là une utilisation directe.

Il est néanmoins certain que ces bactéries permettent le développement de protozoaires. Ainsi, le suivi de petits volumes d'eau de mer fraîche (1 l), filtrée sur 56 µm pour ôter tout invertébré et enrichie tous les jours avec quelques ml de suspension bactérienne, révèle le développement de protozoaires d'une taille moyenne de 15 µm; ils deviennent très nombreux après 4 à 6 j, puis disparaissent après 10 j. En présence de bivalves, des protozoaires se développent très certainement, mais il est difficile de faire la part de cette source trophique indirecte, probablement variable dans le temps, et d'autant moins abondante que les bivalves sont plus gros, avec une capacité de filtration plus importante.

En conclusion, la possibilité d'un production continue de bactéries est susceptible d'ouvrir une voie expérimentale intéressante grâce à la réalisation d'une chaîne trophique. Les vitesses de croissance observées au cours des premières expériences permettent d'appréhender certains des mécanismes qui président à la productivité élevée des étangs littoraux où ces bactéries sont présentes à l'état endémique.

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Egg Production and Viability in the Copepod *Temora stylifera*

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Egg production rates in marine copepods are known to depend on several factors. It has been shown that there is a positive correlation between fecundity and phytoplankton concentration up to a saturation level beyond which reproductive rate remains unchanged. Other studies suggest that variations in food quality interact with food quantity to determine copepod fecundity. However, very little information is available on the viability of these eggs. Viable eggs are defined as those that develop to hatching giving rise to a living nauplius. The concept of egg viability is important for estimating copepod secondary production since it is only this fraction of the total production that is transferred to the next trophic level.

The discarding of non-viable eggs has been reported by many authors in the past and this phenomenon has generally been related to an absence of remating. But IANORA *et al.* (1989) showed that even after remating, hatching success never exceeded 80% and was about 30% for *Temora stylifera* females maintained on a diet of the laboratory-cultured diatom *Thalassiosira rotula* suggesting that factors other than remating determined the production of viable eggs. Recent studies by IANORA and POULET (submtd.) have in fact shown that egg viability or hatching success is strongly dependent on food quality. A dinoflagellate diet (*Prorocentrum minimum*) induced the production of good quality eggs as compared to the diatom *T. rotula*. Here we investigate how diatoms affect egg production and hatching rates in the copepod *T. stylifera*. Diatoms are known to be a major phytoplankton component of productive marine ecosystems and are largely responsible for the spring phytoplankton bloom in most coastal areas of the world. Their role in the feeding biology of copepods has recently been questioned since they may be potentially less nutritious than dinoflagellates or microplankton (KLEPPEL *et al.* 1991).

In this study, zooplankton was sampled in the Bay of Naples from October 1991 and brought to the laboratory within 1h after collection. There, female and male *T. stylifera* couples were sorted individually into crystallizers with 100 ml of 0.45 µm filtered seawater and one of several diatom diets given in excess concentrations (*T. rotula, Chaetoceros curvisetum, Skeletonema costatum* and *Phaeodactylum tricornutum*). These results were compared to those obtained for couples fed the Prymnesiophyceae *Isochrysis galbana* which is widely used in aquaculture and is presumably a good quality food for copepod egg production. Egg counts, egg viability, spermatophore production and faecal pellet production were monitored daily for each couple which was then transferred with a pipette to a new container with fresh media. Details of methods are reported in IANORA *et al.* (1989).

The results obtained for copepod couples fed either *I. galbana, T. rotula* or *C. curvisetum* are shown in the figure. All diets induced egg production but the first two were better than the third for producing more eggs. The diets also differed in their capacity for producing good quality eggs. Hatching success was only about 20% with *T. rotula* and *C. curvisetum* as compared to 79.4% for *I. galbana*. Low egg viability was also observed with the other diatom diets.

IANORA and POULET (submtd.) showed that dinoflagellates were potentially more nutritious than diatoms since they contained higher values of protein, vitamin C, carbon and nitrogen. Our results confirm that diatoms are a poor food item to maintain high egg viability thus placing in doubt the importance of diatoms in the copepod diet. To compensate for a poor quality food, copepods may optimize food conditions by selecting for more nutritious food items such as dinoflagellates. But during periods of high diatom abundances such "selection" may not be possible.

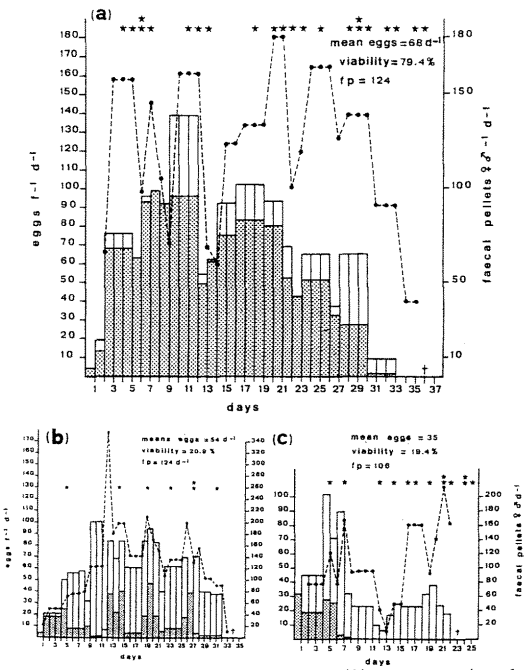

Figure 1: Daily egg production and viability (dark section of histogram), faecal pellet production (dashed line) and spermatophore production (★) for Temora stylifera couples maintained on a diet of (a) Isochrysis galbana, (b) Thalassiosira rotula and (c) Chaetoceros curvisetum.

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Fertilization mechanisms in the Ibiza Channel (Baleares, Espana) in November 1990 and March 1991.

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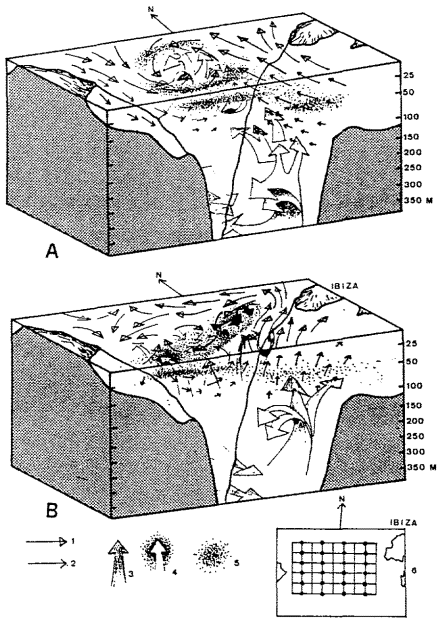
Nutrients dissolved oxygen and chlorophyll distributions are analyzed in relation to hydrographic dynamics (LOPEZ JURADO *et al.* in press) in two different situations observed in cruises carried out in November 1990 and March 1991. Oxygen and nutrients were determined according to STRICKLAND and PARSONS (1972). Chlorophyll a was measured according to spectrophotometric (SCOR/UNESCO, 1966) and fluorimetric (DURAN and JANSA, 1986) methods.

In November (the general analysis of the data is schematized in fig. A), the fertilization process is partially related to the presence of a cyclonic gyre. From nutrient data, a moderate subsuperficial enrichment, as a typical divergence dome in accordance with the gyre, was observed in the central area of the channel. Oxygen saturation percentage distribution showed a similar trend with higher values (> 100 %) more superficial in the central zone of the gyre that in the periphery. At the same time, two chlorophyll a maxima (> 0.5 mg m^{-3}) were observed at 25 m depth at the North and South of the cyclonic gyre respectively. A third maximum at 50 m depth (> 0.8 mg m^{-3}) near Ibiza was observed too, the interpretation of which is more problematic.

In March (fig. B) it appeared a joint process of mechanic accumulation phenomena and a complicated production inputs system, all this are related with a front (in the NE-SW direction) and cyclonic and anticyclonic associated gyres system. Chlorophyll a concentrations are locally important (> 2 mg m^{-3} at 25 m depth) in the frontal area. Also we can observe in this area the maximum nutrient values (nitrates, phosphates and silicates), consequently a water lense appeared between 25 and 50 m depth with deeper water characteristics. Unlikely cruise of November, the dissolved oxygen (> 100 % saturation) is more uniformly distributed in the 0-50 m upper layer.

Considering the two cruises together, the oxygen saturation, from 0 to 50 m depth, is higher than 100 %. Nutrient values are low and very similar to other observations (DEYA, 1978; ESTRADA and MARGALEF, 1988). As well the high chlorophyll a values measured in March have been previously observed in other areas of the Western Mediterranean Sea (DURAN and JANSA, 1986; ESTRADA and MARGALEF, 1988; FORTEZA *et al.*, 1988).



1 : surface current, 2 : subsurface current, 3 : vertical circulation, 4 : coincidence of nutrient supply with chlorophyll a maxima, 5 : chlorophyll a maxima, 6 : stations chart.

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Données préliminaires sur certains organismes vivants intervenant dans les processus de transferts actifs sur la marge continentale

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Parmi les facteurs qui interviennent sur les flux de matière au niveau de la marge continentale, l'un est représenté par les biotransferts liés aux comportements migratoires des organismes vivants appartenant aux faunes pélagiques et benthopélagiques.

Deux types de transferts sont envisagés :

- les transferts de matière directement liés aux animaux migrateurs, ces derniers constituant la matière organique transférée.
- les transferts de matière assurés par les animaux migrateurs, ces derniers étant considérés seulement comme vecteurs, les éléments organiques ou minéraux transférés étant distincts de ces organismes.

L'étude du premier type de transfert a débuté par l'analyse des déplacements horizontaux des animaux bentho-hyponeustoniques du plateau vers la marge, et leur devenir en zone bathyale.

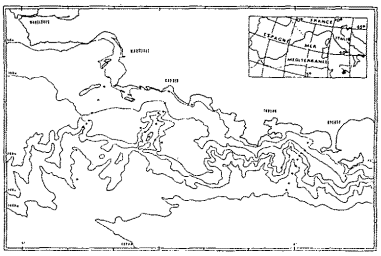

Fig.1: Stations de pêches planctoniques

A cet effet des séries de pêches planctoniques nocturnes, superficielles et verticales, sont régulièrement effectuées au cours d'une même nuit, au-dessus des divers isobathes, de -50m à -1.500m, selon des radiales perpendiculaires à la côte provençale. L'analyse des pêches planctoniques nocturnes effectuées dans l'axe des canyons (Toulon, Cassidaigne, Marseille) met en évidence une extension vers le large, souvent importante, des populations d'espèces fréquentant ordinairement les profondeurs moyennes du plateau (les Mysidacés : *Anchialina agilis, Haplostylus lobatus, Siriella norvegica*, l'Isopode *Eurydice truncata*).

Cette extension se réalise exactement suivant l'axe des canyons jusqu'au-dessus des profondeurs voisines de 1.500 m.

Les espèces restent très rares au-dessus des rebords du plateau, de part et d'autre des canyons, même au-dessus des fonds situés entre - 100m et - 200m.

Pour l'étude du second type de transfert, deux Isopodes Cirolanidae fouisseurs ont été sélectionnés comme modèles vecteurs de matières : *Cirolana borealis* et *Eurydice truncata*. Ils peuvent vivre par des profondeurs supérieures à -300m et présentent des mouvements verticaux nocturnes à l'interface eau-sédiment (*Cirolana*) ou dans l'ensemble de la colonne (*Eurydice*). Ces migrations sont controlées par un rythme circadien endogène d'émergence du sédiment et d'activité natatoire.

Les deux espèces sont étudiées sur le plan de la biologie (KAIM-MALKA, 1992) ou du comportement (MACQUART-MOULIN, 1976, 1985, 1992). L'étude des possibilités de transferts par ces animaux est abordée par l'étude des variations de leur état nutritionnel, et par l'analyse de leur potentialité de fixation de certains traceurs d'origine anthropique, métaux en particulier.

Une première étape a été consacrée à un approfondissement des données biologiques de l'espèce profonde *Cirolana borealis* ; nous avons par la suite procédé à la recherche des matières bioaccumulées susceptibles d'être transférées.

Les observations faites tant au laboratoire que dans le milieu naturel, montrent que par rapport à des espèces de faible profondeurs, le rythme biologique est plus lent (ex : rythme de mue), mais la potentialité de vie est plus grande (3 ans environ). Quatre à cinq classes d'âges sont présentes simultanément au cours de l'année. Il semble qu'il n'y ait qu'une période de reproduction dans l'année, mais qu'elle soit assez étendue dans le temps (automne - hiver), les jeunes apparaissent à la fin de l'hiver ou au début du printemps.

Le problème de la nourriture qui constitue l'un des problèmes les plus importants en milieux profonds, est résolu de plusieurs manières :

1) stockage important de nourriture ;
2) atrophie du tube digestif postérieur ;
3) pas de rejets de déchets solides du fait de l'absence de communications entre l'estomac et le tube digestif postérieur.

L'étude du milieu intérieur révèle que l'hémolymphe est un milieu complexe composé de nombreuses fractions protéiques dont les plus importantes sont des cuproprotéines (hémocyanine et ses différentes sous-unités). Si l'hémocyanine est proche de celles connues chez d'autres espèces de crustacés, en particulier les Isopodes, elle présente une spécificité dans le mode d'association-dissociation et pourrait représenter peut-être une réponse biologique et physiologique de l'espèce aux conditions du milieu. Chez *Cirolana*, les sous-unités (50Kda) pourraient s'associer par 3 (--> 150Kda) ou par 8 (--> 400Kda), alors que chez l'Idotée par exemple les sous-unités de poids 60Kda peuvent s'associer par 6 (--> 360Kda) et s'agréger par 2 (--> 720Kda).

L'étude des substances bioaccumulées et transportées par l'espèce vectrice montre que *Cirolana* piège un nombre important d'éléments traces. L'étude a été faite par une microanalyse au moyen d'une microsonde couplée à un microscope électronique à balayage (Philips SEM 515). Cette étude a permis la mise en évidence de fortes concentrations de nombreux métaux :

Mg, Al, Si, P, S, Ci, K, Ca, Se, Cr, Fe, Ni, Cu, Zn, Sn, Ti.

Les plus fortes concentrations s'observent dans les caecums, le tissu adipeux ventral et les différents tissus musculaires. La nature des éléments traces bioaccumulés semble être très spécifiques en fonction du tissu animal observé, et cela n'est pas sans conséquences biologiques pour les espèces exposées, transportant ou accumulant de telles substances.

Ces études sont en cours de développement aussi bien chez les espèces benthopélagiques que pélagiques.

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Temporal variation of the different developmental stages of Chaetognaths in the Gulf of Kisamos (Cretan Sea)

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There is little information available on the temporal variation of the different developmental stages of chaetognaths in Eastern Mediterranean. FURNESTIN (1958) studied the phases of maturity of specimens found in the sector Libyan-Cretan Sea and the Aegean Sea and GHIRARDELLI (1951) studied the phases of sexual maturity in the gonads of *Sagitta enflata* Grassi in the Gulf of Napoli. MASSUTI-OLIVER (1954) has also reported data on the reproductive cycles of some chaetognath species in the Western Mediterranean.

Samples were collected from four stations during six sampling periods, i.e. 9 September and 20 November 1988, 23 February, 8 April, 23 May and 29 July 1989. Two stations were located on the continental shelf and the remainder at the edge of the continental slope, according to the hydrography of the area. A Bongo net with 500µm mesh size was used for the collection of the samples. Oblique hauls were taken from 50m to the surface. About 80m3 of water were filtered in each haul. We classified the species into stages of maturity based primarily on the development of the ovary and the seminal vesicles using a modification of GHIRARDELLI's (1961) system. Stage I: young without visible ovaries. Stage II: immature with visible ovaries but no visible seminal vesicles. Stage III: seminal vesicles present, ova visible, a few large. Stage IV: filled seminal vesicles and ova large.

The total chaetognaths showed a maximum of abundance in November (322.5 n/100m3) and a minimum in May (82.5 n/m3). There was no statistical difference between the samples collected from the four stations (one-way Anova, $p<0.05$). Seven chaetognath species were identified. The neritic species *Sagitta enflata* was dominant (d=139.2 n/100m3, 70.9%) and with two pelagic species: *Sagitta serratodentata* (d=27.7 n/100m3, 14.1%) and *Sagitta bipunctata* (d=17.4 n/100m3, 8.8%), accounted for more than 90% of the total chaetognaths in the samples. Four other species, the epipelagic Sagitta minima and the deeper living species *Sagitta lyra, Sagitta hexaptera* and *Krohnitta subtilis*, were collected in lower numbers. The presence of the pelagic species proved exchange of pelagic and neritic waters in the Gulf.

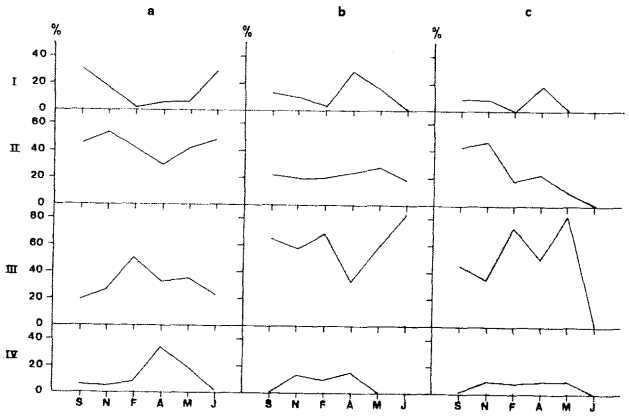
Sagitta enflata: The total population showed a peak of abundance in November (260.3 n/100m3). Stage I was present in the samples during all sampling periods and showed higher relative density in July and September. Stage II was more numerous among all stages of development (mean relative density 42.7%) and showed a peak of abundance in November (136.8 n/100m3, 52.5%). Stage III (mean relative density 30.7%) did not show significant temporal variability. Adults were found all year round and showed a peak in April (Fig.1).

Sagitta serratodentata and *Sagitta bipunctata*: Both two species showed higher abundance in February (90.6 n/100m3 and 51.3 n/100m3 respectively). *S. serratodentata* stage I was absent from our samples in July and showed higher relative density in April. The relative density of stage II specimens remained almost constant during the six sampling periods. Stage III specimens were the most numerous (mean relative density 60.7%) with a peak in July (81.8%). Stage IV was found from November till April. No specimen of *S. bipunctata* was found in July. Stage I was present in the samples only in September, November and April. Stage II and III showed a progressive decrease and increase respectively from September till May. Adults were found from November till May in percentages within the range of 8.0 - 9.1% (Fig.1).

Our results on the breeding of the abundant chaetognaths of Kisamos Gulf showed that: *S. enflata* might reproduce all year round with a major summer breeding period, while *S. serratodentata* and *S. bipunctata* might have two breeding periods, a major one in the spring and another one in autumn.

According to earlier publications *S. enflata* reproduces in February and October in W. Mediterranean (MASSUTI-OLIVER, 1954) while all year round in Miami (OWRE, 1960). *S. bipunctata* reproduces in May and September in the former region (MASSUTI-OLIVER, 1954) and is capable of spawning more than once in the latter. Two major breeding periods were also reported for *S. serratodentata* in fall and in winter (OWRE, 1960).

Fig.1 Seasonal distribution of the developmental stages (I,II,III,IV) of *Sagitta enflata* (a), *Sagitta serratodentata* (b) and *Sagitta bipunctata* (c).



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Variations nycthémérales des activités enzymatiques digestives du copépode *Anomalocera patersoni*

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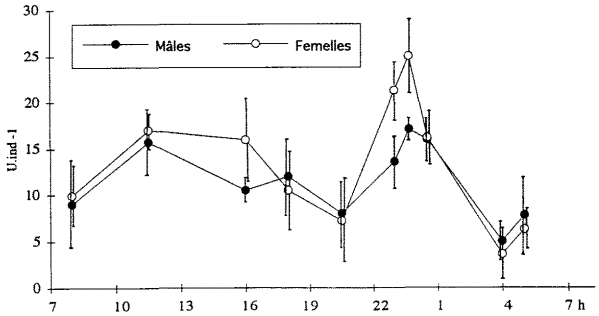
Les fluctuations des activités enzymatiques digestives, représentatives de la nutrition des copépodes (BOUCHER et SAMAIN, 1974), sont susceptibles d'être liées à un rythme nycthéméral (BOUCHER et SAMAIN, 1974) ; MAYZAUD *et al.*, 1984; MAYZAUD, 1985). Le copépode Pontellidé *Anomalocera patersoni*, caractéristique du biotope superficiel, n'effectue pas de migrations verticales marquées mais présente toutefois un rythme endogène d'activité (CHAMPALBERT, 1978). Il était donc intéressant d'étudier au niveau individuel les variations nycthémérales d'activité des enzymes digestives chez cette espèce hyponeustonique.

Les animaux étudiés ont été récoltés au large de Marseille au cours de cycles de 24h effectués en février 1991 et 1992. Les adultes, triés selon le sexe, ont été placés dans l'azote liquide immédiatement après leur récolte. L'activité amylasique, mesurée selon la méthode de STREET et CLOSE (1956), a été exprimée par individu. L'activité de 19 hydrolases a été testée par la méthode API-ZYM (Bio-Mérieux, France). Les résultats obtenus en 1991 ont permis de définir une période d'activité nocturne importante suivie d'une période d'activité minimale des enzymes digestives; en 1992, les échantillons ont été resserrés autour de ces périodes (Figures 1 et 2).

L'activité amylasique moyenne varie de 3 à 4 U. ind^{-1} à 25 U. ind $^{-1}$, avec des valeurs extrêmes individuelles de 0,6 et 29 U. ind $^{-1}$. Elle montre un maximum très net aux alentours de minuit, avec une augmentation qui commence à se manifester à 23 h. Une chute importante se produit au cours de la nuit jusqu'à un minimum vers 4 et 5h. Au cours de la matinée, l'activité amylasique augmente progressivement jusqu'à un maximum diurne, atteint vers 12h (16 U. ind $^{-1}$).

Figure 1 : Variations nycthémérales de l'activité amylasique chez *Anomalocera patersoni*



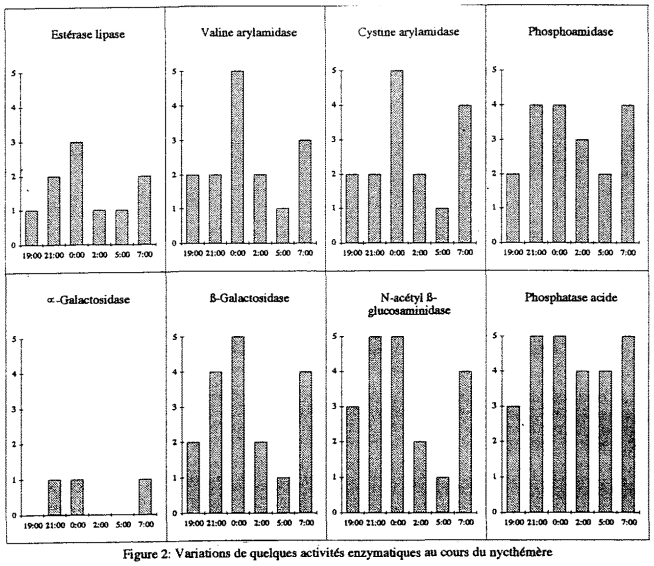


Figure 2: Variations de quelques activités enzymatiques au cours du nycthémère

Les tests API-ZYM montrent que 9 des 19 hydrolases testées présentent un maximum d'activité à minuit alors que le minimum d'activité s'observe à 5h.

Ainsi, il apparaît que les activités enzymatiques digestives d'*Anomalocera patersoni* présentent un caractère cyclique accusé au cours du nycthémère. L'activité amylasique en particulier atteint, au cours du pic nocturne, des valeurs particulièrement élevées pour une espèce carnivore ; l'amplitude des variations observées dépasse largement celle de l'espèce phytophage *Calanus finmarchicus* (BAMSTEDT, 1988). Ces variations d'activité des enzymes digestives traduisent l'activité nutritionnelle cyclique de ces organismes, et sont vraisemblablement en relation avec les variations cycliques de comportement liées à un rythme endogène.

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Evolution de l'activité amylasique chez *Leptomysis lingvura* en élevage au laboratoire

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Les variations quantitatives des activités enzymatiques digestives apparaissent comme un bon indice de l'activité trophique des organismes (BOUCHER et SAMAIN, 1974). Néanmoins, les modifications qualitatives ou quantitatives de la nourriture disponible peuvent avoir des répercussions sur différentes activités enzymatiques, en particulier les amylases et la trypsine (MAYZAUD et CONOVER, 1976; HARRIS *et al.*, 1986). Expérimentalement, plusieurs difficultés apparaissent pour cerner l'impact du régime alimentaire sur ces activités enzymatiques : l'effet de stress dû au changement des conditions de vie, la modification qualitative du régime alimentaire, la modification des rythmes nutritionnels en fonction des apports de nourriture. Si les nouvelles conditions offertes aux organismes permettent leur survie, il est intéressant d'appréhender leurs possibilités d'adaptation pour parvenir à un nouvel équilibre.

Le Mysidacé *Leptomysis lingvura* G.O.Sars, choisi pour cette étude, a été récolté dans la région de Marseille. Les animaux ont été placés dans des aquariums de 10 l d'eau de mer aérée par de grosses bulles et maintenue à une température voisine de celle du milieu. Après une période de 24h de jeûne, deux expériences ont été réalisées : l'une à moyen terme (une semaine) a consisté à nourrir quotidiennement deux lots d'animaux respectivement avec du Tétramin (nourriture pour poissons d'aquarium) et une poudre d'Ulves ; l'autre à long terme (4 semaines) n'a comporté qu'un seul lot d'animaux nourris avec du Tétramin. Des échantillons de 4 ou 5 individus ont été prélevés tous les jours pour la première expérience, une fois par semaine pour la seconde et ont été conservés au congélateur jusqu'au moment de l'analyse. L'activité amylasique a été mesurée selon la méthode de STREET et CLOSE (1956) et exprimée par individu, en unités arbitraires (correspondant à l'hydrolyse de 20 µg d'amylose en 15 min, à 37°C, pH 7,0).

Les animaux fraîchement récoltés présentent, à l'arrivée au laboratoire, une activité amylasique moyenne de 17,6 U.ind^{-1}. Les femelles ont généralement une activité supérieure à celle des mâles, mais la différence n'est pas significative. Au cours des 24h de jeûne, l'activité amylasique augmente, mais après le 1er jour d'élevage, les valeurs observées chez les animaux des deux lots sont significativement plus élevées que celles des témoins à jeûn. Toutefois il n'existe pas de différence entre les deux lots, ni en fonction du régime, ni en fonction du sexe.

Au cours des 8 jours suivants (Fig.1), on observe une augmentation du taux d'activité amylasique : - faible avec les Ulves, mais le niveau atteint est significativement différent de celui observé le premier jour (t=2,16*), - importante avec le Tétramin, les valeurs moyennes obtenues étant plus de 2 fois supérieures aux valeurs de départ. L'activité amylasique des deux lots d'animaux diffère dès le 4 ème jour de manière très hautement significative (t=9,51***).

Le premier prélèvement de l'expérience à long terme fournit la valeur de 61,6 U. ind^{-1}, très voisine de celle obtenue le 7 ème jour de l'expérience précédente (64 U. ind^{-1}). A l'issue de la 2 ème semaine, l'activité diminue fortement et se stabilise au cours des 2 semaines suivantes à un niveau voisin de celui atteint le 2 ème jour de la première expérience.

Les résultats obtenus montrent que l'activité amylasique de *Leptomysis lingvura* est susceptible de présenter des variations importantes, de 17 à 61,6 U. ind^{-1}, l'activité maximale étant obtenue avec le régime Tétramin. Les valeurs observées chez les animaux en expérience mettent clairement en évidence l'existence d'une relation tout à fait siginificative entre l'activité amylasique et la qualité du régime alimentaire sur une période de 8 jours, l'augmentation de l'activité amylasique étant significativement plus rapide avec le Tétramin et sans commune mesure avec les variations observées pendant le jeûne (HECQ *et al.*, 1981, SAMAIN *et al.*, 1985). Une régulation semble intervenir après une semaine avec une baisse rapide de l'activité amylasique qui reste néanmoins toujours plus importante que chez les animaux fraîchement récoltés. A ce moment on peut estimer que la stabilité des valeurs reflète un nouvel état d'équilibre, puisque les animaux sont susceptibles de survivre sans aucune mortalité.

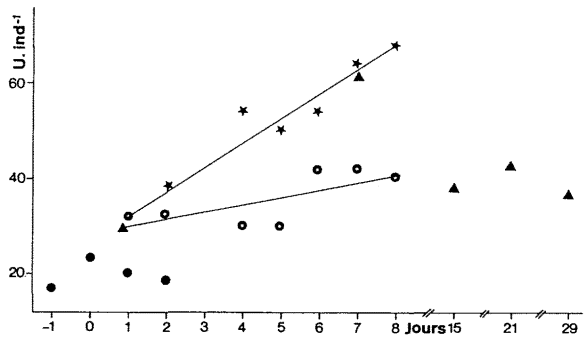

Fig. 1. Evolution de l'activité amylasique de *Leptomysis lingvura* en fonction du régime alimentaire. Première expérience (durée 8 jours): ○ animaux nourris avec des Ulves; ★ animaux nourris avec du Tétramin; ● animaux à jeûn. Seconde expérience (4 semaines): ▲ animaux nourris avec du Tétramin. Jour (-1): mise à jeûn; jour (0): début de l'alimentation.

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The planktonic cyanobacteria int the Gulf of Aqaba, Red Sea : Species composition and biomass

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Earlier records of Cyanobacteria in the northern part of the Gulf of Aqaba off Eilat (Fig.1) revealed two annual peaks, in May-June and October-November, coinciding with the transition periods in the temperature of the water (KIMOR and GOLANSKY, 1977). These peaks were found to consist mainly of *Trichodesmium eythraeum*, recently reidentified as *T. thiebautii* (courtesy A. SOURNIA), occurring mostly in the surface waters down to about 100m, then gradually diminishing with depth.

Current studies of the planktonic microbiota were carried out at an offshore and at a reef station in the same area using the filter-transfer-freeze (FTF) technique for collection and preservation (HEWS and HOLM-HANSEN, 1983). The algal biomass was calculated by multiplying cell volume by cell/biomass conversion factor (STRATHMANN, 1967). These studies indicated the occurrence of *T.thiebautii* during October 1989 and October 1990 (Fig.2). In October 1989, it constituted 61.13% C of total autotrophs in the surface layer, gradually declining with depth to 6.26% C at 60m. However, the overall biomass within the whole water column was low (0.2-0.3gr C m2). The minor record of *T. thiebautii* during October 1990 was located at 80m depth and its biomass was similarly very low. A second *Trichodesmium* species, identified as *T. hildebrandtii* (courtesy A. SOURNIA), characterized by broader and shorter cells, was also recorded sporadically in the samples.

A number of *Oscillatoria* species, both at the off-shore and at the reef sampling stations, varying in cell size and shape, add to the species diversity of Cyanobacteria in the Gulf, though not necessarily to the autotrophic biomass. They may however be transition forms rather than well-defined species. The occurrence of the lilttle-known species *Katagnymene pelagica* is significant, as this appears to be the first record after its original description at the turn of the century (LEMMERMANN, 1899; KARSTEN, 1907).

The chroococcoid Cyanobacteria are represented in the Gulf by the ubiquitous *Synechococcus/Synechocystis* populations, which constitute an important component of the total autotrophic biomass (Fig.2). Among the colonial forms, the ephemeral occurrence was recorded of *Aphanocapsa litoralis* with amorphous thallus without any definite shape and of the raft-shaped *Merismopedia* sp.

Symbiotic Cyanobacteria have been found to occur either as ectobionts, known as phaeosomes, in the horizontal grooves of heterotrophic dinoflagellates or as trichomes of nitrogen-fixing *Richelia intracellularis*, within several species of centric diatoms of the genera *Rhizosolenia* and *Hemiaulus*.

None of the species recorded so far in this study was found in bloom condition. However, some species, both free-living and symbiotic, are known to have the ability to fix molecular nitrogen in oligotrophic seas and, as such, they may be important to the nitrogen budget of the Gulf. Furthermore, the co-existence of two species of *Trichodesmium* in the plankton of this environment requires further elucidation as to their ecological requirements and bloom-forming ability.

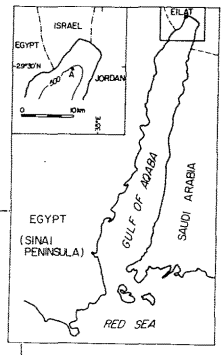

Fig.1: Location of the study area in the Gulf of Aqaba off Eilat (inset).

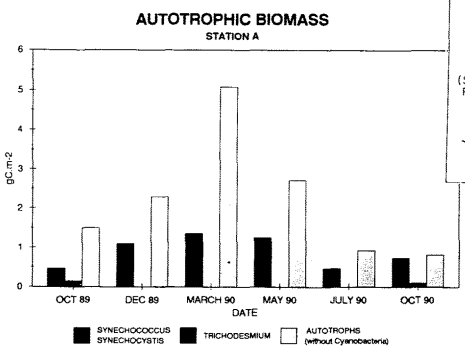

Fig.2: The contribution of Synechococcus/Synecocystis and Trichodesmium (gr C/m^2) to the total autotrophic biomass with the whole water column, October 1989-October 1990.

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Zooplankton structure and distribution in the Bulgarian Black Sea coastal eutrophicated zone in summer 1991

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The results of the zooplankton structure and distribution investigations in the Bulgarian Black Sea coastal waters are very important, for explanation of the phenomena related to the eutrophication processes. Most interesting in this aspect are the summer development and distribution of the main constituents as well as that of some species which in the past have been rarely found or were almost absent from the coastal waters (DIMOV, 1960; KONSOULOV, 1986).

The results discussed in the present report concern tne zooplankton of the shallow shelf zone in front of the Bulgarian coast with sea water quasihomogeneous structure during the summer of 1991. The samples were collected with a plankton net "Djeddy" (mesh size 100 mikrons) at stations located on ^{3}, 10, 20 and 30 miles eastward from Krapets and cape Emine, at standard horizons for a stratified water basin. Monospecific biomass is calculated according to standard weights by IASHNOV (1934).

In the coastal region up to 3 miles offshore the unicellular euryphage *Noctiluca scintillans* is present with the highest quantitative abundance and biomass (555.52 mg/m^3) in the summer zooplankton, followed by *Pleopis polyphemoides* (26.8 mg/m^3), *Acartia clausi* (20.82 mg/m^3), *Penilia avirostris* (11.32 mg/m^3), *Cirripedia nauplii* and *Polychaeta larvae*.

At the same time 10 miles offshore *N. scintillans* participation abruptly drops: its share of the total biomass in this region (70.75 mg/m^3) comprising species of Copepoda, Cladocera and benthic larvae, only amounts to 48.32% (34.18 mg/m^3). Significantly lower quantitative abundance of Cladocera species is established in this same area and also affects the value of the biomass (Fig. 1).

A. clausi dominates in the quantitative structure of the zooplankton in the 20 miles offshore zone (23.18 mg/m^3) followed by *P. polyphemoides* (17.44 mg/m^3), *Evadne tergestina* (5.24 mg/m^3), *Acartia copepodites*, *A. nauplii*, *Evadne spinifera* and *P. avirostris larvae*. *N. scintillans* is registered here with quantity of 2.5 mg/m^3.

Thirty miles east from the coast the zooplankton is represented mainly by *A.clausi*, *P. polyphemoides*, *Pseudocalanus elongatus* and *N. scintillans* with biomasses of 5,09, 7,48, 2,75 and 2.16 mg/m^3 respectively.

A more detailed analysis of these results shows that during the summer of 1991 the highest biomass values were due mainly to *N. scintillans* and *Cladocera species*. This fact allows us to consider this zooplankton complex as an indicator of the coastal zone higher eutrophication level in comparison with the open sea area. Moreover, the exclusively high biomass of *N. scintillans* in the coastal region determines to a large extent the changes in the biogenic potential, the intensity of phosphorus recycling and the mechanism of the plankton coenoses reproduction.

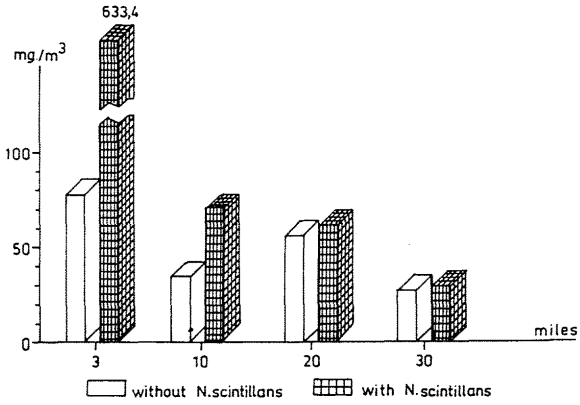

Fig. 1. Zooplankton biomass value (mg/m^3)

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Temperature, light and nutrient based model on spring primary production for heavily eutrophied subtropical coastal waters (1)

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Noxious algal blooms caused by toxigenic or non-toxigenic phytoplanktonic species during spring has attracted increasing attention worldwide especially since 1980's. Besides neurotoxic, paralytic and diarrhatic shellfish poisoning toxins, sometimes only anoxia has caused mass mortalities of many marine consumers during these toxic and/or nontoxic blooms (STEIDINGER, 1983; WYATT, 1990). In any case, these blooms have constituted a risk factor both as a threat to public health and aquaculture in sub-tropical regions such as eastern coast of Aegean Sea, Izmir Bay (JACQUES and SOURNIA, 1980; KORAY, 1987; MONTRESOR *et al.*, 1990). Although the impact of red-tides on some fish species has been documented since 1950's for the region (NUMANN, 1955; ACARA and NALBANDOGLU; 1960; KORAY, 1984; KORAY and BUYUKISIK, 1988; KORAY, 1990), little is known how the primary and secondary ecological factors influence red-tides and other noxious spring phytoplankton bloomings.

This study was conducted in the inner part of Izmir Bay in which "color-tides" were continuously observed between March and July. Bi-weekly or three weekly visits to the four sampling stations were carried out to provide a detailed time series. The water samples were collected from 0.5, 2.5, 5.0 and 10.0 m. with a Hydro-Bios water sampler (1.5 l^{-1}) and were stored in polyethylene bottles in the dark and cool carrying boxes for chemical analyses. Temperature and light were determined *in situ*. Inorganic nutrigenous nutrients, silica phosphate, pH, salinity, Chl-a and phaeopigment determinations were realized in the laboratory according to the procedures of STRICKLAND and PARSONS (1972).

In this study, an empirical multiple regression model was used to develop a predictive equation between dependent variable Chl-a, and the physico-chemicals that were thought to be independent but potentially important to phytoplankton production during spring bloomings. Standardization of the dependent and independent variables (n=109 for each variable) were required to eliminate the effect of differences in measurement scale, to show the relative standardized strenghts of the effects of independent variables on the Chl-a and stabilize the variance. For prediction equation, $\log_{10}(Y_i+1)$ transformation was preferred to simplify conversation to original measurement units and to normalize the data. The stepwise selection procedure was used to obtain estimate of the regression coefficients and significant relationships. The standardized data were also used for PCA.

The multiple regression equation in standard format with orthophosphate P, temperature, light, Si, ammonium N and nitrate N was highly significant ($F = 17.551$, $p < 0.05$) respectively and explained 52 % of the total variance in the data (Table I). The standard partial regression coefficients indicated that as P, temperature, light and nitrate N increased, Chl-a increased.

Table I: Parameters of multiple regression equation in standard format for dependent variable Chl-a (standardized variables).

Variables	Reg.	Coeff. F	Sig. level
Orthophosphate P	0.499	20.474	0.000
Temperature	0.358	20.241	0.000
Light	0.288	15.656	0.000
Si	-0.217	5.369	0.022
Ammonium N	-0.214	5.306	0.023
Nitrate N	0.152	4.029	0.048

Si and ammonium N are inversely correlated with the Chl-a increases.

This pattern clearly established Si controlled bloom succession. Although P was the most important parameter affecting the equation, it was never limiting because of rapid recycling and continuous inputs from sewage.

For predictive purposes, conventional regression without intercept was obtained as function of the same variables;

$$\log(\text{Chl-a}+1) = 1.445 \log(PO_4^{-3}+1) + 0.676 \log(T+1) + 0.132 \log(L+1) - 0.518 \log(SiO_4+1) - 0.128 \log(NH^+_4+1) + 0.199 \log(NO^-_3+1)$$

The six environmental independent variables described 92 % of the total variance in predictive regression equation, however, effects of ammonium and nitrate were almost negligible in the final predictive regression ($p < 0.46$).

The principal component analyses performed on the standardized nutrients, primary ecological factors, light, primary (Chl-a) and secondary (phaeopigments) production units described 95 % of the total variance within the nine PCs. The first seven PCs which were used to calculate multiple regression equations explained 88 % of the variation in production during blooming season. The eigenvectors were included in Table II. Practically, the first PC can be interpreted as a nutrient concentration and biomass component (P, ammonium N, Si and Chl-a). PC 2 summarized biomass and photosynthetic activity (Chl-a, DO, pH, nitrite N) while the other PCs were generally interpreted as nutrient and primary ecological factor components.

Table II: The component weights of the first seven PCs.

Variables	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7
P	0.516	-0.148	0.083	-0.092	-0.049	0.059	-0.016
Ammonium N	0.351	-0.260	-0.319	-0.022	-0.260	-0.210	-0.454
Nitrate N	0.127	0.139	-0.360	-0.038	-0.733	0.118	0.253
Light	0.232	0.279	-0.279	0.309	0.287	-0.397	-0.130
Temp.	0.258	0.289	0.320	-0.495	-0.080	-0.112	0.008
Si	0.384	-0.291	0.239	0.262	0.023	0.015	-0.309
Chl-a	0.338	0.449	0.055	-0.105	-0.053	0.148	0.081
Oxygen	0.055	0.486	0.378	0.113	-0.000	0.126	-0.342
pH	0.007	0.434	-0.414	0.324	0.101	0.044	-0.030
Nitrite N	-0.262	0.037	0.251	0.420	-0.431	0.275	-0.030
Salinity	0.177	-0.041	0.368	0.486	-0.175	-0.409	0.556
Phaeo.pig.	0.331	-0.127	-0.092	0.200	0.272	0.697	0.262

Both multiple regression coefficients and principal components indicated that phytoplankton biomass during blooms increased with increasing P, nitrate N, light and temperature. Species succession was mainly controlled with Si. These informations also suggest that phosphorus controls the amount of phytoplankton biomass in red-tide season, however, phosphorus loading in the system is adequate and never limiting in eutrophied Izmir Bay.

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Phytoplankton blooming and zooplankton swarms in eutrophied zones of Aegean Sea (Izmir Bay) (1)

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The ecological importance of the phytoplankton blooming and zooplankton swarms have become little recognized in the Eastern Mediterranean and Aegean Seas. However, the effect of eutrophication on this events has been shown in the past decade (AUBERT et AUBERT, 1988; KORAY, 1990; STIRN, 1988), particularly on ciliated protozoans and micrometazoans (REVELANTE *et al.*, 1985) in the Mediterranean and Adriatic Seas. In the Eastern Aegean Sea and Izmir Bay which are under the effects of discharges of Izmir city, eutrophic increase in biomass of phyto-, protozooplankton and micrometazoans have been reported by JACQUES and SOURNIA (1980), KORAY (1988) and KORAY *et al.*, (1990).

The purposes of this study were to obtain an updated species list of blooming and/or swarming plankton for Eastern Aegean coasts and to quantify their basic ecological properties.

The samples which were evaluated in this study were collected from 1990 to 1992, with sampling concentrated in spring-summer with bi-weekly periods. Monthly or bi-monthly sampling was carried on during autumn and winter. Quantitative bottle and qualitative net samples were collected regularly. Species determinations were mainly realized with living specimens. However, formalin and lugol preserved material were used for enumeration of settled samples.

At the end of the observations, twenty nine species of marine plankton representing ten different classes were identified (Table I). Phytoplanktonic members of the list clearly showed a yearly succession and their total biomass increased from oligotrophic toward the eutrophic zones of the bay. During the pronounced and widespread blooms of dinoflagellates (*P. micans, N. scintillans, A. minutum, G. simplex, S. trochoidea*), seawater was strikingly discoloured red. Coccolithophorides, diatoms and euglenoids were also associated with different discoloration of seawater such as milky (*E. huxleyi*) or green (all the diatoms, euglenoids and prasinophytes).

The increases of tintinnid populations were closely related to the blooms of the same species of phytoplankton. Both *F. campanula* and *H. subulata* formed swarms during diatom *N. closterium* blooming in the inner eutrophied zone of the bay. The non-tintinnid ciliate *M. rubrum* exhibited its own characteristic periodicity and were observed during particular upwelling periods. The neustonic patches of the radiolarian *S. zanclea* were most pronounced in less eutrophied mixing zones. The swarms of the ctenophore *B. hydatina* were dependent on the wind direction during the late spring and were clearly associated with *N. scintillans*, also drifted by wind on the surface. However, a clear predator/prey relationship between the dinoflagellate and ctenophore could not be implied. The well-known grazers, *A. clausii, O. nana* and their nauplii, meta-nauplii formed huge swarms in the eutrophied zones of the bay in summer and middle autumn. The tintinnid *F. campanula* can compete efficiently with *A. clausii* and *O. nana* for similar phytoplanktonic food under eutrophied conditions. The planktonic swarms along the Eastern coasts of Aegean Sea and in Izmir Bay were mainly wind dependent when they located at surface waters and/or partly neustonic (e.g. *N. scintillans, S. zanclea* and *B. hydatina*). However, the gradual increase in phytoplankton, protozooplankton and micrometazoa blooms and/or swarms is probably related to the eutrophication, availability of nutrients and food size of the prey crop.

Table I : Blooming and/or swarming species of plankton of the Eastern coast of Aegean Sea and in Izmir Bay during the years 1990-1991.

Species	Date (Months) 1990	1991	Temp. (°C)	Sal. (‰)
DINOPHYCEAE				
Alexandrium minutum	4,5	4	15.5-19.4	37.63-38.00
Gonyaulax polyedra	4,5	-	16.3-18.6	37.56-37.93
Gymnodinium simplex	3,4,5	4,6	15.5-16.3	37.51
Gyrodinium spirale	4,5	4	15.5-16.5	37.03-37.85
Noctiluca scintillans	3,4,5,6	3,4,5,6	15.5-20.8	37.51-39.25
Oxytoxum scolopax	4,5,6	4	15.5-25.6	37.63
Prorocentrum micans	2,3,4,5,6	4	10.2-25.6	36.20-39.25
P. minimum	3,4,5	-	15.5-22.3	37.56-38.28
P. triestinum	4,5,6	4,6	15.5-25.6	37.60-39.25
Protoperidinium steinii	4,5	4	15.5-22.6	37.63-38.05
Scripsiella trochoidea	3,4,5	4	15.5-22.6	37.51-38.00
PRYMNESIOPHYCEAE				
Emiliania huxleyi	5,6	5,6	22.5-25.6	36.88-37.60
CHRYSOPHYCEAE				
Bicoeca mediterranea	5,6	5,6	18.0-25.6	36.88-37.35
BACILLARIOPHYCEAE				
Nitzschia closterium	3,4,5	4,5	15.5-22.3	37.51-38.27
N. pungens	4,5	4,5	15.5-22.3	37.63-38.00
Thalassiosira allenii	5,6	4,5,6	18.0-25.6	36.88-37.43
T. anguste-lineata	3,4,5	4	15.5-22.3	37.51-38.05
EUGLENOPHYCEAE				
Eutreptiella cf. lanowii	6,7	-	18.0-22.3	36.88-37.43
E. gymnastica	5,6,7	4,6	15.5-22.3	36.88-37.05
PRASINOPHYCEAE				
Pyramimonas propulsum	5	5	20.8-21.0	36.00
RADIOLARIA				
Sticholonche zanclea	3,4	3,4	15.5-18.2	37.27-38.2
CILIATA				
Favella campanula	5,7	-	18.0-22.3	38.66
Helicostomella subulata	3	4,5	13.7	37.51-37.82
Tintinnopsis cylindrica	4	-	16.3	37.6
Mesodinium rubrum	4,10	4,10	15.5-20.2	37.4
CTENOPHORA				
Bolina hydatina	5,6	5,6	20.0-22.9	36.82-36.86
CRUSTACEA				
Acartia clausi	7,9	7,9	21.9-26.5	37.62-38.96
Centropages kröyeri	9	9	23.6	38.80
Oithona nana	7,9	7,9	21.9-26.5	37.62-37.96

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P

Les Amphipodes hypériens des eaux libanaises : composition et distribution

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Dans le cadre des inventaires faunistiques du plancton du Liban, il est intéressant d'étudier les Hypérides qui, malgré leur faible biomasse, possèdent une grande richesse spécifique. Les résultats sont basés sur l'analyse d'un très grand nombre de prélèvements effectués au filet WP2 200 microns entre 1970 et 1990 en surface et en profondeur (600-0m) et en divers points de la côte libanaise (LAKKIS, 1990). Pour la détermination des espèces, nous avons eu recours aux travaux de CHEVREUX et FAGE (1925), SHIH et DUNBAR (1963), STEPHENSON (1918) et BOWMAN, (1978).

Sur les 40 espèces d'Hypérides recensées en Méditerranée occidentale (LAVAL, 1968a) et en Adriatique (HURE *et al.*, 1969), 25 sont trouvées dans les eaux levantines, la plupart rencontrées dans des pêches profondes à l'état libre. LAVAL (1980) considère que les Hypérides parasitent les organismes gélatineux (méduses, siphonophores, salpes et dolioles) avec un choix préférentiel de l'hôte, selon l'espèce parasite. La plupart des espèces rencontrées ne présentent pas une distribution saisonnière particulière; elles sont plus fréquentes en surface durant la période hivernale d'homothermie (décembre-mars). Une seule espèce, *Tetrathyrus forcipatus* montre toutefois une population en juin. Les espèces les plus fréquentes sont : *Eupronoë minuta, Primno macropa, Lestrigonus schizogeneios, Phronima sedentaria et Vibilia armata*, les trois premières étant également les plus fréquentes en Adriatique méridionale. Sur les 25 espèces trouvées dans nos eaux levantines, une seule, *Themisto oblivia*, n'est pas en Méditerranée occidentale et une espèce *Phronima sedentaria* serait commune avec la faune de la mer Rouge (HALIM, 1969). 18 espèces existantes sont aussi signalées dans l'Indo-pacifique (REPELIN, 1978). La liste complète et leur distribution saisonnière figurent au Tableau. En février, on note la richesse en espèces la plus élevée (15 en moyenne sur 20 ans), puis en juin (12). Par contre en été durant la période thermique chaude coincidant avec la stratification hydrologique et la thermocline (juin-octobre), les pêches de surface sont pauvres en espèces, la plupart des Hypériens restant confinés aux couches plus profondes. D'ailleurs la plupart des individus pêchés dans la couche 50-0m sont surtout des juvéniles ou des immatures.

La pauvreté relative en espèces et en nombre d'individus chez les Hypérides, serait inhérente aux lacunes dans les méthodes de pêche. En effet les pêches profondes n'ont pas été fréquentes et régulières et les pêches superficielles n'ont apporté que très peu de spécimens. Par ailleurs la vie parasitaire implique des précautions particulières dans la pêche pour éviter le colmatage du filet qui provoque une détérioration des spécimens. Ainsi, d'après LAVAL (1980), les prélèvements des Hypériens devraient être effectués au moyen du filet Isaacs-Kidd ou par plongées, pêches nocturnes etc... De telles méthodes de pêche qui nous manquaient, auraient donné les résultats souhaités; chose que l'on tentera d'obtenir dans un avenir proche.

Liste et distributions saisonnières des Hypérides rencontrés dans les eaux libanaises entre 1970 et 1990.

ESPECES/ MOIS	J	F	M	A	M	J	J	A	S	O	N	D	%Fréq.
SCINIDAE													
1-Scina crassicornis(Fabr.)..	-	-	-	-	-	x	-	-	-	-	-	-	8
VIBILIIDAE													
2-Vibilia armata Bovallius...	x	x	x	-	-	x	-	-	-	-	-	-	33
3-Vibilia viatrix Bovallius..	-	x	x	-	-	x	-	-	-	-	-	-	25
PARAPHRONIMIDAE													
4-Paraphronima crassipes Cl.	-	x	-	-	-	-	-	-	-	-	-	-	8
HYPERIIDAE													
5-Lestrigonus schizogen.Steb.	x	x	x	-	-	x	-	-	-	x	x	x	42
6-L.latissima Bovallius.....	-	-	x	-	-	x	-	-	-	-	-	-	17
7-Hyperioides longipes Chev.	-	x	x	-	-	x	x	-	-	-	-	-	25
8-Themisto oblivia(Kröyer)..	-	-	-	-	-	-	-	-	-	x	x	-	17
LYCAEIDAE													
9-Lycaea pulex Marion.....	x	x	-	-	-	-	-	-	-	-	-	x	25
PHRONIMIDAE													
10-Phronimopsis spinifera(Cl.)	x	x	-	-	-	-	-	-	-	-	-	x	25
11-Phronima atlantica Guérin..	-	x	x	-	-	-	-	-	-	x	-	-	25
12-Phronima sedentaria(Fors.)	-	-	x	x	-	x	-	-	-	-	-	-	25
13-Phronimella elongata(Claus)	-	x	-	-	-	x	-	-	-	-	-	-	17
PHROSINIDAE													
14-Anchylomera blossevillei ME	-	-	-	-	-	x	-	-	-	-	-	-	8
15-Prosina semilunata Risso..	-	x	x	-	-	-	-	-	-	-	-	-	17
16-Primno macropa(Guérin)....	-	x	x	-	x	x	x	-	-	-	-	x	50
LYCAEOPSIDAE													
17-Lycaeopsis themistoides Cl.	-	x	x	-	-	-	-	-	-	-	-	-	17
18-Eupronoë minuta Claus.....	x	x	-	-	x	x	-	-	-	x	x	-	50
19-Eupronoë maculata Claus...	x	x	-	-	-	x	-	-	-	-	-	-	25
BRACHYSCELIDAE													
20-Brachyscelus crusculum Bate	-	x	-	-	-	-	-	-	-	-	-	-	8
OXYCEPHALIDAE													
21-Oxycephalus piscator M.-Ed.	-	x	-	-	-	-	-	-	-	-	-	-	8
22-Rhabdosoma brevicaudatum St.	-	x	-	-	-	-	-	-	-	-	-	-	8
PLATYSCELIDAE													
23-Platyscelus serratulus Steb.	-	x	-	-	-	-	-	-	-	-	-	-	8
24-Amphithyrus sculpturatus S.	-	x	-	-	-	x	-	-	-	-	-	-	17
25-Tetrathyrus forcipatus Cl.	-	-	-	-	-	x	-	-	x	-	-	x	25

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P

Variations biométriques annuelles chez *Sagitta enflata* et *S. friderici* des eaux côtières libanaises

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Dans nos inventaires faunistiques du zooplancton du Liban, 10 espèces de Chaetognathes sont mentionnées avec une prédominance de *S. friderici* (85%) suivie de *S. enflata* (10%) (LAKKIS, 1977). Etant donné l'importance de ces deux espèces, il était intéressant de connaître les variations biométriques de la taille et des ovaires au cours d'un cycle annuel.

Deux lots de 500 individus chacun ont été triés dans les échantillons planctoniques prélevés au filet WP2 de 200 microns en plusieurs stations côtières et au large en traits de surface et verticaux (50-0m) entre 1988 et 1989 (LAKKIS, 1989). Ces specimens ont fait l'objet de mesures biométriques concernant la longueur totale (LT) et les ovaires (OV), ainsi que le rapport entre ces deux variables.

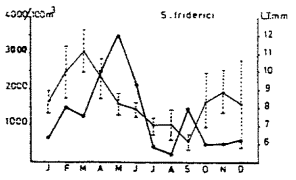
Sagitta friderici Ritter-Zahony, 1911. La répartition saisonnière présente 3 pics annuels, le plus important étant en avril-mai (50 ind./m3); les deux autres sont observés en septembre et en février. Des individus sexuellement mûrs persistent en février et mars pour donner une population printanière de taille 7-8mm et une autre estivale entre 6 et 7mm en juillet-août. En septembre, la taille moyenne est la plus petite de l'année (6mm). Des individus de grande taille sexuellement mûrs réapparaissent en octobre-novembre; alors que la population de décembre est hétérogène comprenant des individus jeunes ainsi que des adultes (Fig.1). Ce cycle annuel chez *S. friderici* est comparable à celui trouvé dans les eaux d'Alexandrie (HALIM et GUERGUESS, 1973). Les 5 groupes de taille les plus fréquents rencontrés sont ceux de 6, 7, 8, 9 et 10mm (Moyenne 8,5mm); les tailles supérieures à 10mm ne représentent que 3% de l'ensemble de la population (Fig.2). Le rapport % Ov/LT qui est un critère morphométrique et sexuel est plus grand chez la population de la Méditerranée orientale (9-15%) que celle de l'Atlantique marocain où il est 3-10% (FAURE, 1952). Une légère baisse de ce rapport est notée dans les deux secteurs pour l'intervalle de taille 11-13mm en Atlantique et 10-12mm dans les eaux levantines (Fig. 3.). Le tableau suivant montre les variations mensuelles de ce rapport :

Mois	J	F	M	A	M	J	J	A	S	O	N	D
X LTmm	8,3	10	11,1	9,6	8,2	7,9	7	7,1	6,1	8,4	8,9	8,2
%LOv/LT	4	19	13	12	13	12	13	13	12	16	12	12

Sagitta enflata Grassi, 1881. Quatre pics annuels d'abondance sont observés dont le principal en mai-juin (80 ind./m3) et 3 autres modérés en février, septembre et décembre (Fig. 4). Rappelons que *S. enflata* a une affinité pour les eaux chaudes (FURNESTIN, 1957), d'où son développement estival. A ces 4 pics d'abondance correspondent 4 groupes de taille dont la moyenne est supérieure à 16mm. Les groupes de taille les plus fréquents sont ceux situés entre 16 et 18mm, les tailles les plus grandes étant observées en février et novembre (20 et 30mm), mais avec des variabilités beaucoup plus grandes que pour les groupes de taille plus petite (Fig. 5). Les tailles les plus grandes représentent 12% de l'ensemble de la population. La majorité des individus examinés (60%) sont à ovaires courts, comme c'est le cas pour la population méditerranéenne (FURNESTIN, 1957). Les variations mensuelles du rapport % Ov/LT donnent les résultats suivants :

MOIS	J	F	M	A	M	J	J	A	S	O	N	D
X LTmm	14,5	20,3	17,5	18,5	17,5	15,6	15	15,5	14,3	12,9	18,5	15.5
%LOv/LT	4	8	5	3	9	7	7	6	5	3	4	4

Conclusion. La population de *S. friderici* dans les eaux levantines est caractérisée par des ovaires plus longs que ceux de l'Atlantique; cette différence serait due à des facteurs biogéographiques et hydrologiques différents dans les deux secteurs. Alors que *S. enflata* est à ovaires courts comme la population méditerranéenne. Les deux espèces présentent la taille maximale en hiver et en automne.



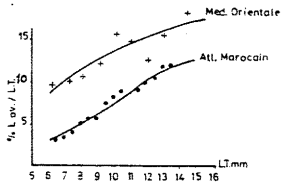
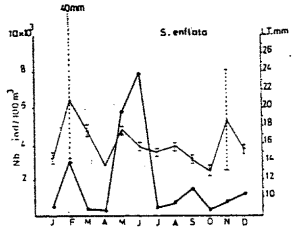


Fig.5. Variations du rapport % LOv/LT chez S.friderici La courbe relative à l'Atlantique marocain est empruntée à FAURE(1952)



Figs.1 et 4. Variations mensuelles de l'abondance et de la taille chez Sagitta friderici et S.enflata

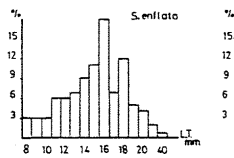


Fig.5. Histogramme de fréquence de la taille chez S. enflata (n=500 ind.)

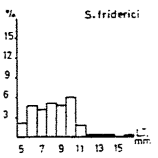


Fig.2. Histogramme de fréquence de la taille chez S.friderici (n= 500 indiv.)

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Morphogenesis of the larval and juvenile tunic in *Halocynthia papillosa*

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The highly organized adult tunic of the ascidian *Halocynthia papillosa* (VAN DAELE, 1990) calls for a study elucidating the formation of such complex structures. In order to survey tunic morphogenesis from the onset of tunic secretion it is necessary to rear embryos, larvae and juvenile ascidians under confined experimental conditions. Since the reproductive cycle of *Halocynthia papillosa* has not yet been described, the maturation of the gonad was monitored for a whole year. During their main breeding season (September, October) adult animals were collected in the vicinity of the Marine Biological Station at Banyuls (France, Mediterranean Sea). Individuals were kept in separate tanks supplied with running seawater.

Spawning of gametes is light-controlled. Under natural light conditions, it takes place shortly after sunset. Naturally spawned eggs were fertilized with non-self sperm and reared in filtered seawater at 14-15°C. Embryogenesis was completed within 42h. Although the tadpole larvae failed to attach to all offered substrata, they started metamorphosis after a short free-swimming period. Juveniles were kept until they reached the age of three months.

Until tunic secretion is initiated at the early tail-bud stage, the embryos have a smooth epidermis. Then, patches of tunic material are seen on the embryonic surface. In TEM micrographs, these patches appear as a fine discontinuous ribbon which gives rise to the outer cuticle of the larval tunic. Soon after, the embryo is completely covered by the larval tunic and the test cells settle onto the tunic. By the middle tail-bud stage, when melanin is synthesized in the sensory vesicle, a ventral, a dorsal and a short caudal fin have developed. At this stage, the larval tunic consists of the outer cuticle, a rigid fibrous sheet of medium electron density, and the outer compartment. Patches of dark-staining material are irregularly distributed over the tunic surface. This material has a fibrous appearance in SEM micrographs and seems to be associated with test cells. Seconds only before the larva hatches, the test cells detach from the larval tunic. A second fibrous sheet then develops above the apical epidermal membrane of the trunk, the inner cuticle. Some hours later, the trunk tunic consists of the outer cuticle, the outer compartment, the inner cuticle and the inner compartment while the tail epidermis is enveloped only by the outer cuticle and the outer compartment. The outer and inner compartments are composed of granular and fibrous material embedded in a hydrated ground matrix. SEM shows a swimming larva with a few small fins around the trunk and bigger fins, one dorsal and one ventral, lining the tail. Most striking is the hexagonal pattern of the trunk tunic.

Radical metamorphosis starts with elongation of the anterior part of the trunk, retraction of the adhesive papillae, immobilization of the larva, and retraction of the tail. During tail retraction, the first cells pass through the epidermis and enter the inner compartment of the tunic. This process is confined to a small region just anterior to the sensory vesicle. Once the tail is retracted, gaps form between the inner cuticle and the outer compartment. In the following three days the outer cuticle and the outer compartment of the trunk tunic as well as the tail tunic are shed. Only two days after the onset of metamorphosis, the tunic forms the first spines, a feature characteristic of the adult tunic. In the course of tunic morphogenesis, the cuticle forms plates, each carrying a spine. Once the juvenile has lost the outer layer of the larval tunic, the tunic consists of a thin fibrous cuticle and a fundamental layer. There is only very little fibrous material distributed throughout the whole fundamental layer. Some intratunical cells lie directly underneath the cuticle. They all belong to the same cell type. As tunic morphogenesis proceeds, the ultrastructural complexity increases. The diffuse net of fibrous material is progressively replaced by fibres oriented parallel to the epidermal surface except in regions where spines have developed. There, bundles of fibres form the core, supporting the spines. At least one new cell type is then found in the fundamental layer of the tunic. Observations with the light microscope show that intratunical cells are motile.

In juveniles three months old, the tunic has yet not attained the structural complexity of the adult tunic.

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Biomasse et Production primaire du picoplancton phototrophe en Mer Méditerranée

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Plus de dix ans se sont écoulés depuis que l'on a reconnu l'importance que le picoplancton photosynthétique, et en particulier la classe des Cyanobactéries, revêt pour l'écosystème marin. Au cours de cette période, l'intérêt des biologistes marins pour ces organismes de petites dimensions (2.0-0.2 µm) distribués de façon abondante dans toutes les mers et tous les océans, s'est accru.

Les premières indications sur la présence et l'activité photosynthétique du picophytoplancton en mer Méditerranée ont été fournies en 1983 au cours de la IV Conférence de l'"European Society for Comparative Physiology and Biochemistry" (Taormina, 5-8 septembre 1983) et concernent deux zones particulières de la mer Méditerranée, le Détroit de Messine (MAGAZZU' *et al.*, 1986) caractérisé par un haut dynamisme et les eaux oligotrophiques du Bassin Oriental au large des côtes israëliennes (AZOV, 1986).

Toutefois, contrairement à ce qui s'est passé pour les autres mers et pour les océans, les informations sur la distribution, l'abondance, la physiologie et la biochimie de ces organismes et, en définitive, sur leur rôle dans la chaîne alimentaire marine en mer Méditerranée sont encore très limitées.

Dans cette note, nous rapportons les résultats relatifs à la biomasse et à la production primaire de la fraction phytoplanctonique comprise entre 2.0-0.2 µm obtenus en mer Tyrrhénienne du Nord et Méridionale, en Adriatique du Nord, en mer Ionienne, dans le Canal de Sicile et dans le Détroit de Messine. Ils englobent les milieux côtiers et le large (DECEMBRINI et MAGAZZU', 1990).

Dans les zones examinées, l'apport du picophytoplancton à la biomasse exprimée en chlorophylle active (dosage spectrofluorimétrique, dans extrait acétonique à 90%) et en ATP (dosage par voie enzymatique luciférine-luciférase) s'est révélé très semblable pour ces deux paramètres avec une moyenne respectivement de 62% et de 54% (Tab.1) du total. Les valeurs moyennes de biomasse picoplanctonique par zone ont oscillé d'un minimum de 0.04 µg/l à un maximum de 0.35 µg/l avec une moyenne générale de 0.20 µg/l pour la CHLa et d'un minimum de 0.001 µg/l à un maximum de 0.045 µg/l avec une moyenne générale de 0.019 µg/l pour l'ATP. Suite à une analyse plus approfondie des données, il ressort que la fraction picoplanctonique comprise entre 1.0-0.2 µm, attribuable fort probablement aux Cyanobactéries, est celle qui a une incidence majeure sur la biomasse avec des pourcentages de 50% et de 39% du total respectivement pour la chlorophylle active et l'ATP.

L'assimilation du C14 associée aux organismes de dimension inférieure à 2.0 µm (méthode décrite récemment MAGAZZU' et DECEMBRINI, 1990) donne un résultat compris entre 42% et 80%, les valeurs les plus élevées obtenues en milieu oligotrophique et au large. Le pourcentage moyen pour l'ensemble des zones étudiées donne une valeur de 69% du total, très voisine à celle de la biomasse (CHLa) , qui apparaît fortement influencée par les mesures effectuées en milieux côtiers où, dans des conditions de plus grande concentration en sels nutritifs, la composante phytoplanctonique de dimension > 2.0 µm domine. Les organismes de dimensions comprises entre 1.0-0.2 µm, ont également une incidence considérable sur la production primaire étant donné qu'ils fournissent à eux seuls 61% de la production totale.

Dans un milieu saumâtre côtier eutrophisé, la Lagune de Faro près de Messine, l'apport du picoplancton autotrophe, étudié pendant un cycle annuel entier le long d'une colonne d'eau, s'est révélé nettement inférieur par rapport à celui des eaux marines adjacentes. En effet, la biomasse est comprise respectivement entre 11% et 24% du total pour la chlorophylle active et l'ATP, alors que l'assimilation du carbone de cette fraction < 2.0 µm a donné un résultat de 42% (MAGAZZU' *et al.*, 1989).

Le rapport C14/CHLa relatif au picoplancton autotrophe se révèle généralement plus élevé dans toutes les zones examinées à celui obtenu pour le plancton total, ce qui indique par conséquent une efficience photosynthétique plus grande de la fraction plus petite. Le même rapport présente des valeurs basses dans les milieux côtiers, où les organismes > 2.0 µm dominent, et il augmente considérablement dans les milieux pélagiques où l'incidence picophytoplanctonique est majeure.

TAB.1 - Biomasse et assimilation du C14 dans les differentes zones étudiées.

Milieux	Total			% 2.0-0.5 µm			C14/CHLa	
	CHLa	ATP	C14	CHLa	ATP	C14	> 2.0	2.0-0.5
	µg/l		µgC/l/h					
mer Tyrrhénienne	0.51	0.06	1.04	70.2	68.8	70.9	2.1	2.0
mer Adriatique			3.75			54.0		
mer Ionienne	0.36	0.00	1.08	65.7	50.6	75.3	1.1	3.9
Canal de Sicilie	0.05		0.77	67.3		80.0	11.1	16.8
Détroit de Messine	0.46	0.03	1.41	45.4	43.2	67.0	1.0	6.4
Lac de Faro	14.25	0.67	7.28	11.1	24.0	41.8	0.3	1.9
Milieux côtiers	0.56	0.03	2.25	52.8	43.2	61.8	3.0	4.4
Milieux du large	0.32	0.05	0.89	67.8	64.3	75.4	5.5	12.7

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The structure of planktonic communities in a meromictic coastal lagoon (*Estany del Cibollar*, Majorca)

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The *Estany del Cibollar* (*Albufera d'Alcudia*, Majorca) is a small coastal lagoon (3.99 ha, 8.25 m maximum depth, and 3.30 m average depth). It is characterized by a permanent meromixis due to the presence of seawater at depth. This phenomenon causes thermal inversion during winter and anoxia in the monimolimnion (MOYA *et al.*, 1987). At the chemocline, the concentration of dissolved oxygen increases sharply (up to 24 mg O_2/l and 330% saturation in April). Where oxygen is depleted, H_2S is present, increasing in concentration towards the lake floor. Analysed nutrient values indicate an eutrophic situation. Nitrogen in nitrate form is found in high concentrations at surface levels due to the inflow of a tributary stream whilst at depth, nitrate is replaced by ammonium. Phosphorus shows a progressive increase in the monimolimnion, especially close to the bottom due to its redissolution from the sediment.

Planktonic communities found in the *Estany del Cibollar* were sampled monthly during 1991. A very distinctive pattern of distribution of these communities, in response to the existence of meromixis, may be confirmed (MIRACLE *et al.*,1983).

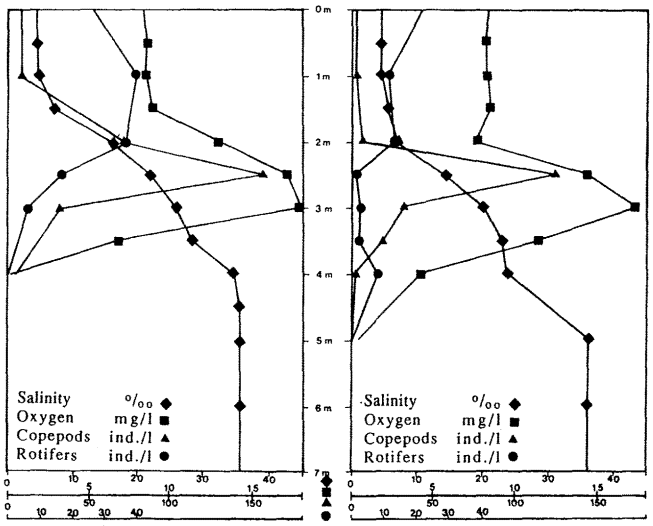
The phytoplanktonic community present in the mixolimnion is basically formed by Cryptophyceae and Chrysophyceae, with densities varying between 1000 and 10 000 cells per millilitre.

There is a significant concentration of cyanobacteria of the genus *Synechococcus*, which shows maximum densities in the metalimnion (up to 17 million cells per millilitre). The high oxygen values registered at this level are the result of the activity of this population and coincide with maximum values of Chlorophyll-a (CRAIG, 1987).

In the upper part of the monimolimnion, a community of phototrophic sulphur-oxidizing bacteria is present which utilises the existing H_2S.

The zooplanktonic community is dominated by copepods and rotifers. Their respective distributions show a different spatial distribution related to physicochemical and biotic factors throughout the vertical profile (FERRARI *et al.*, 1982).

The vertical structure of the planktonic communities and the distribution of the physico-chemical parameters are given in the diagrams and table enclosed. They illustrate two different points in the annual cycle: March and June.



MARCH 1991				JUNE 1991		
Chl. a (mg/m^3)	Phytoplankton (cells/ml)	*Synechococcus* (cells/ml)	Depth (m)	Chl. a (mg/m^3)	Phytoplankton (cells/ml)	*Synechococcus* (cells/ml)
2.94	1504	----------	0	1.84	9761	----------
2.93	4716	----------	1	1.45	7243	----------
4.25	5882	6.16×10^6	2	1.14	-----	1.03×10^6
4.39	8452	6.19×10^6	2.5	3.76	8856	2.98×10^6
9.83	-----	17.06×10^6	3	6.58	-----	12.05×10^6

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Environmental conditions which determine chrysophyte *Apedinella* development and blooms

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The modificatons of phytoplanktonic community during the last decades (MIHNEA, 1987, MIHNEA *et al.*, 1980) also include the occurence of some new representatives the number and frequency of which are still increasing. One of them is the chrysophyte *Apedinella* (THRONDSEN, 1971) that produces blooms. Our observations were carried out from 1975 to 1989 in the southern part of the Romanian inshore area along the 13 transects, 5, 10, 20 m isobaths. Samples (1,000 ml) were collected monthly at standard depths (0, 5, 10, 20 m), between February and October. On the whole 2,332 phytoplanktonic samples were analysed. Determinations regarding macronutrients and physical parameters were also done. As macronutrients are not limiting within the studied area, a correlation between this new organism and organic compounds produced by *Skeletonema* was found to help partially the explanation of its bloom (MIHNEA, 1992). Although *Apedinella* was present in Spring-Summer and sometimes in Autumn associations (Table 1), its massive development or bloom could be correlated with the large variation of silicium level (Table 2).

Table 1 : The frequency of *Apedinella* sp. population as its maximum density (no cells/lx10^3; underlined values no cells/lx10^6)

Year/ Month	MARCH	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
1975	0	3.5	140.0	33.0	0	0	0	0
1976	0.2	14.5	5.2	8.4	0.2	0	0	10.6
1977	0	1.4	0	0	0	2.1	1.5	0
1978	0	3.4	0	1.7	11.8	36.4	0	0
1979	108.0	132.0	1.5	31.5	0	0	0	3.0
1980	62.4	8.1	0	1.3	0	1.0	0	1.0
1981	0	0	15.8	0	0	0	0	0
1983	0	1.0	21.5	23.0	41.6	915.0	0	7.6
1984	0	23.4	1.0	237.0	4.0	14.0	0	0
1985	0	34.0	2.0	12.0	10.0	15.0	0	0
1986	0	6.0	13.3	38.0	6.0	12.0	6.0	0
1987	0	16.8	151.0	15.7	0	12.6	0	0
1989	49.0	0	0	2.1	14.9	12.8	0	17.0

Table 2 : Silicium level during the whole year within the studied area (CUINGIOGLU, unpubl.)

Year	Total No of samples	Class size/No of samples(N)/ range of $Si-SiO_2$ variation	
		> 1000 µg/l	< 1000 µg/l
1983	349	41 1006-2000	308 0-960
1984	356	37 1017-3740	319 0-904
1985	335	15 1011-4960	320 53-845
1986	260	25 1005-2685	235 78-945
1987	231	69 1005-6125	162 105-990

April and May are the months when this chrysophyte blooms and correspond with the most reduced level of $Si-SiO_3$. If we only consider the 1986 results, when *Apedinella* cell no/l reached respectively 21.5 and 13.3 x 10^6, silicium concentrations varied on one hand from 0 to 400 µg/l in 35.54% and from 400 to 800 µg/l in 53.85% of the samples (N=104), and on the other hand from 0 to 400 µg/l in 54.0% and from 400 to 800 µg/l in 36.78% of the samples (N=87).

The silicium depletion is due to *Skeletonema* and some other co-associate diatoms which previously developed for a long while; this event plays an important role in shifting the species composition from diatoms to algal flagellates supposed to have limited or to have not Si requests. The sequence is very short but *Apedinella* "takes advantage" and begins its intense divisions. Some other factors could be involved, e.g. the total radiant energy. An increase in total rediant energy during the last decade of April and the first decade of May (Table 3) also could be connected to the promoting of an accelerated division rate of *Apedinella* if it is combined with a 6-10°C range of sea temperature (MIHNEA, 1992). The superimposing of : *Skeletonema* bloom, decrease of Si, 6-10°C range of sea temperature and a rapid increase of light (more than 1000 cal cm^{-2}) should be considered the "conditioning" of sea water for the described chrysophyte development.

During 1984, 1985 and 1987 the total radiant energy had increased in first decade of May, temperature was 10-16°C and the silicium level higher than values determined in 1983 and 1986's Spring; in such a "scenario" the bloom of chrysophyte *Apedinella* didn't take place. We cannot omit the concurrence between species as well the physical forces that could be other conditions of mass development. A tight concurrence between *Apedinella* and dinophyte *Heterocapsa triquetra* was observed, too; they both compete for some "excreted substances", or maybe try to impose their own association to medium diatoms which cannot develop in.

If *Apedinella* cannot develop strongly enough in April, windy Spring weather could stop it by dispersion of its patches.

In conclusion, in eutrophicated marine ecosystems, individual species are controlled by a large set of environmental factors. If anyone changes significantly, it upsets the existing balance and induces a new ecological equilibrium. The bloom is caused by the coupling of the physiological capabilities with the environmental conditions.

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I am deeply indebted to my colleague E. CUINGIOGLU for providing useful unpublished data on silicium.

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Distribution of crustacean micronekton across a Mediterranean front

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Fronts are regions of larger-than-average horizontal gradients of water properties such as temperature, salinity and density, and are places of particular biological significance (LE FEVRE, 1986). In the northeastern part of the western Mediterranean, the Ligurian Sea, the water circulation is characterized by a permanent cyclonic flow running southwest along the French Riviera. This cyclonic circulation is marked by a steep salinity and density gradient (frontal zone) separating the inshore current (coastal and peripheral zone) from the offshore water mass of high surface density (central zone) (PRIEUR, 1981). This geostrophic front is a permanent feature of the Ligurean Sea and its position fluctuates only by a few miles (NM).

The present note reports data on the distribution of crustacean macroplankton and micronekton across the front in late summer (September) 1984. Sampling took place along a 123° transect from Cap Ferrat at 11 stations distant of 3 NM each. The hauls were carried out with an Omori net of 2 m² surface opening and 590 µm mesh size. They were double oblique from the surface down to 200 m depth, and were performed at night to minimize the effect of diurnal migration. The location of the frontal area at the time of sampling was obtained from hydrological data collected concomitantly and was situated at 7-15 NM from the shore (PRIEUR, personal communication).

Twelve species of euphausiids and shrimps were fished. The species names and their total captures are reported in table 1. *Meganyctiphanes norvegica* was the most common species and was clearly concentrated in the central waters, well off the frontal area. *Nematoscelis megalops* was the second most common species and presented peaks of abundance in the frontal zone as well as in offshore waters, but was scarce in coastal waters. The other two species well represented had nonrandom distributions: *Stylocheiron longicorne* was concentrated mainly in frontal waters and *Euphausia krohni* was the only species with a clear preference for inshore waters. The respective abundance of *M. norvegica* and *E. krohni* in the Ligurian offshore/inshore gradient is in opposition to previously reported distributions in NW European waters (MAUCHLINE, 1984). Shrimps were caught only in small numbers and the data gave little information on their distribution.

Table 1.- Species of crustacean macroplankton and micronekton fished in September 1984 and number of specimens caught.

Euphausiids	number	Shrimps	number
Euphausia hemiggiba	2	*Gennadas elegans*	5
Euphausia krohni	206	*Pasiphaea multidentata*	6
Meganyctiphanes norvegica	1409	*Pasiphaea sivado*	21
Nematoscelis megalops	913	*Sergestes arcticus*	2
Stylocheiron longicorne	137	*Sergestes robustus*	1
Thysanopoda aequalis	4	*Sergestes sargassi*	1

The influence of the front on the distribution of the species was studied by correspondence analysis (CA). The aim of the CA is to describe parsimoniously the total inertia of a multidimensional data set in a sample of few dimensions (or axes). Among the inertia methods, CA is concerned with contingency tables and use a Chi-square metric. Only the 7 most abundant species at the 11 stations were retained for the CA. Figure 1 gives the station coordinates on the two main CA axes against their distance from the coast; these two axes accounted for 62.7 % and 32.3 % of the inertia respectively (interpreted as part of information). Axis 1 reflects the opposition between *E. krohni* (coastal species) and *M. norvegica* (mainly offshore species). As shown in figure 1, this effect is related to the distance of the stations to the coast and is most important at the frontal zone. Axis 2 describes the species spatial distribution after removal of the coast-offshore effect. This axis is linked to an opposition between *M. norvegica* and *N. megalops* / *Stylocheiron longicorne*. The three frontal stations are clearly set apart from the others by their low coordinates on the second axis, which is due to a neat dominance of *N. megalops* and *Stylocheiron longicorne* in these stations (Fig. 1).

The data reported indicates that in the Ligurian Sea the distribution of euphausiids is marked by (1) a gradient between offshore and coastal waters; (2) a concentration of some species in the frontal zone. Species associated with the front are predominantly carnivores (*N. megalops* and *Stylocheiron longicorne*) whereas those involved only in the offshore/inshore gradient most probably feed on smaller particles (*M. norvegica, E. krohni*).

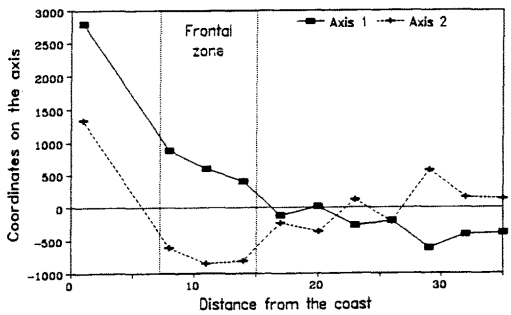

Figure 1. Station coordinates on the two main correspondence analysis axes against their distance from the coast.

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Cysts of blooming dinoflagellates from Black Sea

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The fact that blooms in Black Sea are spreading both in space and time is related to recurently increased anthropogenic impact on the basin (BODEANU 1984, ZAITZEV 1986, NESTEROVA 1987). While there is much information on species involved and environmental factors contributing to these events almost no attention has been paid to dinoflagellates life cycle and its relation to the blooms in Black sea ecosystem. The present paper is aimed at investigation the different stages in life history of the most frequent blooming dinoflagellates along the Bulgarian Black Sea coast.

Both phytoplankton sampling and laboratory culture experiments have been undertaken. Phytoplankton was monitored on monthly and weekly rates in Varna Bay (Bulgarian Black Sea coast) for species composition, abundance outbursts and blooming species populations morphological heterogenity during the period 1984-1991. The details on monoculture procedures and phytoplankton succession are given elswhere Moncheva 1991 a,b). All species counts are made following the inverted microscope technique.

For most of the dinoflagellates blooming along the Bulgarian Black Sea coast, sexual reproduction has already been reported in the literature (Tabl.1)

Heterocapsa triquetra: Vegetative cells are present in the plankton during winter, spring and autumn and entirely absent in summer months with almost regular blooms in April - May. Oval, thick walled structures with d=28-31µ have been registered in May 1988 at a population density of 3.1×10^5 cells/l amounting to 1.9×10^5 cells/l (e.g.64%) at the surface and varying with depth (down to 15 m) from 36 to 72% (fig. 1a). At t° above 20°C no vegetative cells are present in the plankton. Perhaps encystment may be related to t° factor which is quite in agreement with Susumu (1986).

Table 1: Dinoflagellate species blooms along the bulgarian sea coast (1984-1991)

year / species	1984 a	1984 b	1985 a	1985 b	1986 a	1986 b	1987 a	1987 b	1988 a	1988 b	1989 a	1989 b	1990 a	1990 b	1991 a	1991 b	Sexual * cycle known
Prorocentrum minimum	7	8.6	6	0.7	6	480	7	30.5	7	3.2	6	250	6	1.6	7	41.5	ND
	11	60.1	7	0.4													
Heterocapsa triquetra	5	39.5	4	3.8	5	13.6			5	47.3	6	5					+
Prorocentrum micans	11	2.9					10	1					7	1.2	7	1.2	ND
Goniaulax polyedra	11	1.4					10	2.2	7	1.3							+
Scrippsiella trochoidea											7	16	7	0.2	8	1.9	+
Polykrikos schwartzii											6	0.08			7	0.02	+
															8.9	0.05	
Gymnodinium catenatum															7	0.9	+
															8.9	2.7	

a - month; b - abundance (1×10^6 cells/l); ND - no data; * - after MATSUOKA *et al.* (1989)

Prorocentrum minimum: vegetative cells present in the plankton throughout the whole year with local and regional blooms (1979, 1986) both in late spring - summer and autumn months. In June 1988 at t° above 20°C and cell density 9.2×10^5 - 1.5×10^5 (19.4%.) cells/l are dark brown spheres of d=12µ without flagella (fig.1b), the same structures being registered in old lab cultures.

Prorocentrum micans: As vegetative cells also found throughout the year with irregular outbursts (tabl. 1). Naked dark brown spheres of d=30µ found for the first time in 1984 are identical to the structures reported by BRAARUD, ROSSAWICK (1951) as cysts (fig. 1c.). In 1987 at t° 18°C and 1.1×10^6 cells/l they amount to 9.4×10^3 cells/l. In the same sample in von Stosch medium at 22°C in lab the number of vegetative cells increase to 4.5×10^6 cells/l and that of the spheres to 169×10^3 cells/l. In old culture (11.3×10^6 cells/l) they amount to 270.5×10^3 cells/l.

Goniaulax polyedra: Vegetative cells present mainly in spring-summer and autumn months. Cysts are registered for the first time in Nov. 1984. In Oct. 1987 at t° 18°C and concentration of cells 2.2×10^6 the cysts number is 67.6×10^3. In lab at 22°C after 2 days incubation in von Stosch medium the ratio is inverse - 788.9×10^3 vegetative cells and 1.2×10^6 cells/l cysts.

Scrippsiella trochoidea: For the first time the species is found in the plankton in 1989. Cysts (oval cells, d=25-30µ, with very short and tiny spines) identified at t° above 20°C at cell density 1.9×10^6 cells/l in conc. 11.6×10^3 (16.8%) in August 1991. Absent in the plankton in winter - late autumn months.

Polykrikos schwartzii: Absent in the plankton in winter - late autumn months. Cysts identified in July 1989 at the water - bottom interface at a density of 4×10^5 cells/l while the number of vegetative cells in the plankton is 2.5×10^5 cells/l.

Gymnodinium catenatum: A new species in Black sea phytoplankton found for the first time in 1991. No cysts detected yet.

For the species *P. micans* and *P. minimum* whether the cysts are planozygotes or temporary cysts needs further investigation. The role suggested for the cysts includes short and longterm survival in adversory conditions, bloom initiation, species dispersion, genetic restoration but the importance of these roles remains largely hypothetical (PFIESTER and ANDERSON, 1987, BINDER and ANDERSON, 1990). As most of the species reported are present throughout the whole year as vegetative cells, it is rather speculative to consider cysts only a way of survival under unfavourable conditions. As we consider eutrophication an ecological background of high density population maintenance, we are likely to consider sexual reproduction induced by eutrophication, responsible for nuclear reorganization and population genetic restoration (MADHU, 1980).

The documentation of cysts reported makes it possible to revise the concept about phytoplankton assemblages formation along the Bulgarian Black Sea coast (PETROVA - KARADJOVA, 1973) and proves its relative autonomy of development addressing especially the local blooms.

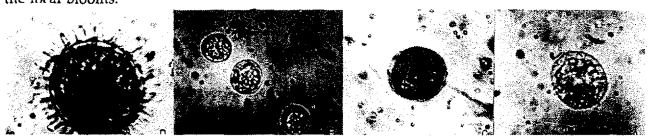

Fig.1: Cysts of *Heterocapsa triquetra* - a; *Prorocentrum minimum* - b; *Prorocentrum micans* c; *Goniaulax polyedra* - d(x750).

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P

Thermal influence of thermoelectric power station "Varna" on Varna Lake ecosystem and ecological impact.

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Varna lake is a brackish lake (mean salinity 16‰) with intensive water exchange with the sea through two channels. As an area where the greatest portion of the industrial and sewage waste waters of Varna region are discharged, it is the main source responsible for the high level of eutrophication and pollution of Varna Bay with strong ecological impact on the marine biota. (MONCHEVA, 1991).

The operational phase of the Thermoelectric Power Station (ThPS) "Varna" situated on north Varna lake coast started in 1967. The once-through cooling circuit is based on deep layers cold water intake by pumps and discharge back to Varna lake system through two channels (Fig.1). At full power the cooling water temperature in the circuit is about 40°-46°C and depending on the season at the discharge points between 27° and 20°C. The investigations are focused on ThPS "Varna" temperature pattern influence assessment and its ecological impact.

The parameters taken into consideration are temperature, salinity, current speed and direction, phytoplankton analyses in qualitative and quantitative terms, (abundance and biomass, chlorophyll "a" and phaeophytin) seasonally during 1990 - 1991 and detail investigations in May 1991.

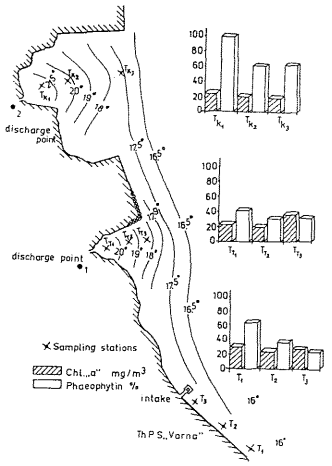

Fig.1. Trends in temperature, chl. "a" and phaeophytin distribution from the closed to discharge points areas.

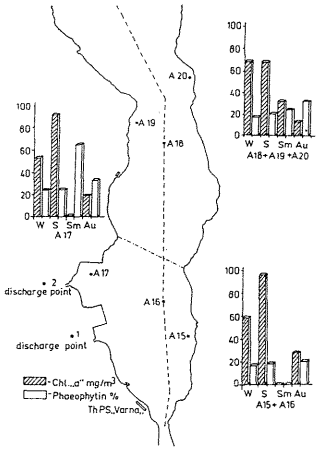

Fig.2. Seasonal pattern of chl."a" and phaeophytin distribution in Varna lake: w - winter; s - spring; sm - summer; au - autumn.

The data reveal that the thermal plume influences an area of 9.2×10^5 m^2 (e.g. 1/4 of the total surface of Varna lake) down to 5m depth, resulting in a local temperature water mass gradient varying between 6 and 10°C (depending on the season) - fig.1.

The discharged water impact includes both oceanographic and biological perturbations of the ecosystem (although restricted mainly to its western part) :

- the temperature gradient induced changes in the stratification of the basin affect water mass circulation and density, resulting in the formation of a horizontal pressure gradient and water mass dynamic processes activation in the area of concern (especially in winter, spring and autumn).
- perturbation in the pattern of development of phytoplankton: significant differences in quantitative terms between the impact (st. A17, A16, A15) and relatively distant areas (st. A18, A19, A20) while the taxonomic structure is almost the same - the main trend being a shift in both chl."a" and phaeophytin in the area of concern (fig.2). As it is known t° increase influences phytoplankton development in several ways: stimulates colonization rate, determines to a greater extent in excystment, generation time and life cycle duration (EPPLEY, 1972, STEIDINGER and HADDAD 1981).

Probably the induced increase in the temperature of closed area waters may serve as a potential initiation factor responsible for high phytoplankton biomass maintenance and conditioning phytoplankton blooms inoculating the whole area through dynamical processes under the high eutrophication level of the environment.

The detailed map of phaeophytin distribution investigation reveals very high values (between 75 - 93 %) at the very close to the discharge points zone slightly decreasing towards the 16° isotherm (fig.1). The high phaeophytin % can not be related to the direct temperature impact (the summer temperature exceeds 26°C). As the temperature of the water in contact with the condensors is 40 - 46°C, it is high enough to cause the death of the living plankton cells to which the mechanical treatment contributes a lot. Taking into account that the mean year phytoplankton biomass is 24.9 mg/l, each pump capacity (250 m^3/h) and average phaeophytin (77 %) it is estimated that the input of fresh - dead phytobiomass amounts to 12kg per fortnight, e.g. 4.4 t per year. The dead matter if not utilized through the food web sinks directly to the bottom.

The excess of phytobiomass produced as a result of the high eutrophication level of Varna Lake (ROJDESTVENSKI, 1991), and the high input dead matter rate induced by the thermal operating cycle of the station create conditions leading to the deterioration of benthic cenoces through a decrease of water transparency, a mechanical overlapping and an oxygen deficiency. As established the benthic cenoces at st. A17 are totally dead and seriously damaged at st. A16, A15 (KONSULOVA, 1991).

The results of the complex investigations give ground to consider the thermal influence of ThPS "Varna" on Varna Lake system as a thermal pollution with strongly expressed indirect negative ecological impact although it is not the only reason responsible of the ecological disaster of the basin.

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Relationships between physico-chemical characteristics and planktonic communities in the Bay of Alcudia (Majorca)

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The physico-chemical characteristics and planktonic communities of the Alcudia Bay have been monitored throughout 1991. Monthly samples were taken from seven stations located along a radius starting from the innermost part, adjoining the coastal marsh *Albufera de Mallorca*, to the outer bay (four stations), with three stations along the coast. Samples were taken from surface to bottom, with 5 m intervals. Results show that there are significant relationships between physicochemical characteristics (salinity, N/P ratio), phytoplankton biomass expressed as chlorophyll *a* and particulate matter, basically zooplankton, collected with a 100 µm mesh net.

The Bay of Alcudia has an input of brackish water from the *Albufera de Mallorca*. This coastal aquatic habitat exports part of the nutrients it takes in from tourist and agricultural activities (MARTINEZ TABERNER *et al.*, 1990). The lower density water arriving in the bay stays at the surface and creates an inverse salinity and nutrient gradient in the water column. The intensity of this gradient and its incidence in the outer bay depend on the water flow from the *Albufera*, water density, nutrient load and S and SE wind action; all these parameters may vary over the year.

Nutrient concentrations display great temporal and spatial heterogeneity (horizontal and vertical). Nitrate values are always high at the surface in the area near the *Albufera*. In the rest of the Bay values are high at certain moments of the year. Phosphorus concentrations are generally low, with very localized peaks in both time and space. Due to this variability N/P values are greatly dispersed around the 16/1 quotient considered optimum for phytoplankton growth (GOLDMAN *et al.*, 1979).

Chlorophyll *a* concentrations exhibit a pattern of variation dependent on the N/P ratio. Maximum values of chlorophyll *a* coincide with ratios above 16/1, while minimal concentrations of chlorophyll are associated with very low N/P ratios. This behaviour suggests that at certain moments of the annual cycle and at certain points in the bay, N and/or P are limiting factors for phytoplankton growth. The annual phytoplankton dynamics is modified by the entry into the bay of brackish water rich in nutrients. This surface enrichment is the cause of significant phytoplankton development, fundamentally of small flagellates (Cryptophyceae and Chrysophyceae) during spring and autumn.

The annual variation of zooplankton, expressed as mg organic matter m^{-2}, is closely linked with changes in phytoplankton biomass as mg chlorophyll *a* m^{-2}. The zooplankton biomass/chlorophyll *a* concentration ratio ranges from 12.03 to 53.67, with a mean of 28.77 and standard deviation of 13.76. Maximum values correspond to situations where the phytoplankton is mainly made up of nanoplankton species (small flagellates) with low chlorophyll *a* concentration per cell. As in similar latitudes (NASSOGNE, 1972; FERNANDEZ DE PUELLES & GARCIA BRAUN, 1989) in these cases the nauplii of copepods found were dominant in the zooplankton.

The minimum, maximum, mean and standard deviation (in brackets) shown in the table express the range of variation of the parameters discussed in this contribution. Salinity: extreme values for all levels sampled. N/P ratio: integrated means for each station. Chlorophyll *a* concentrations: total chlorophyll *a* per unit surface for each station. And zooplankton biomass (> 100 µm): as organic matter concentration per unit surface in any station.

	SALINITY ‰	N/P	Chl *a* mg m^{-2}	ZOOPLANK (>100 µm) mg m^{-2}
JANUARY	24.65-37.22	7.14-35.83 16.77 (9.05)	1.39-7.09 3.17 (2.00)	-
FEBRUARY	8.52-37.20	8.53-46.40 27.58 (12.89)	3.31-15.20 8.14 (4.04)	47.10-153.75 113.31 (47.20)
MARCH	32.56-37.31	1.38-21.89 8.74 (7.05)	0.55-4.08 2.12 (1.08)	9.75-291.00 83.16 (120.03)
APRIL	17.10-37.44	3.05-48.00 20.04 (14.81)	1.63-4.53 2.64 (1.01)	65.50-270.00 141.70 (76.94)
MAY	7.71-37.29	3.40-196.75 47.79 (64.48)	1.41-5.38 3.60 (1.29)	14.50-368.00 159.22 (129.36)
JUNE	12.46-37.41	3.14-51.80 21.22 (17.22)	1.93-3.33 2.61 (0.47)	16.70-143.80 86.65 (47.00)
JULY/10	26.22-37.34	2.16-81.00 26.17 (28.17)	0.83-4.18 2.21 (0.93)	15.00-98.60 45.30 (31.75)
JULY/24	29.87-37.35	1.11-334.38 50.21 (116.01)	3.38-6.03 4.88 (1.50)	33.35-176.00 79.51 (56.45)
AUGUST	23.50-37.50	2.93-88.63 24.06 (28.19)	1.85-3.35 2.51 (0.85)	-
SEPTEMBER	36.50-37.50	2.20-174.20 41.09 (57.01)	0.65-7.33 3.64 (2.85)	-
OCTOBER	21.40-37.29	3.20-51.30 21.43 (18.57)	0.97-9.58 4.66 (3.06)	17.95-170.80 83.64 (55.20)
NOVEMBER	24.03-37.41	63.58-207.50 115.88 (45.87)	0.63-6.13 3.13 (1.80)	17.60-63.20 37.65 (18.59)
DECEMBER	29.87-37.35	2.63-97.60 32.82 (33.73)	0.78-5.50 3.28 (1.74)	24.10-275.00 120.30 (95.50)

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Données concernant l'hyponeuston des eaux côtières roumaines de la Mer Noire

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L'hyponeuston est une communauté particulière du pélagos (2) peuplée d'organismes zooplanctoniques doués de certains traits éthologiques qui leur permettent d'affronter des conditions extrêmes.

A partir des échantillons prélevés durant l'été 1991 (juin, juillet et août), à l'aide d'un filet à traction horizontale (section de 10 cm x 50 cm, vide de maille 100 µm, vitesse de traction de 10 m. minute^{-1}) et après une interruption d'une vingtaine d'années, l'étude de l'hyponeuston des eaux côtières roumaines de la mer Noire a été reprise. Un réseau de 22 stations situées sur 11 profils perpendiculaires à la côte entre Cap Midia (44°21'N) et Mangalia (43°49'N) a été choisi. Les valeurs moyennes de densité (D = ex.m^{-3}) et de biomasse en poids frais (B = mg.m^{-3}) pour la saison estivale concernant la couche superficielle de 10 cm sont données ci-dessous :

Profil		hauteur de 10 m par rapport au fond					hauteur de 20 m par rapport au fond				
		ZIK total	Méro-plancton	Copé-podes	NS	ID	ZIK total	Méro-plancton	Copé-podes	NS	ID
CAP MIDIA	D	960	60	870	3	0,53	1440	150	1260	5	0,78
	B	5,48	0,10	2,98			34,35	12,97	18,98		
NAVODARI	D	4940	260	4680	3	0,34	4770	1350	3360	5	1,37
	B	20,94	0,80	20,14			87,96	27,73	54,62		
MAMAIA CASINO	D	4040	500	3500	4	0,65	3100	200	2800	4	0,61
	B	25,54	1,08	21,86			18,17	0,83	9,34		
MAMAIA (IRCM)	D	14750	5200	9350	4	1,143	3500	720	2780	2	0,733
	B	47,06	29,82	15,44			9,25	1,22	8,03		
PORT TOMIS	D	-	-	-			13604	5204	7400	5	1,85
	B	-	-	-			216,96	138,96	69,00		
CONSTANTA	D	7958	4080	3750	6	1,69	5292	190	4440	8	0,98
	B	455,02	180,92	8,50			73,19	2,21	51,30		
EFORIE NORD	D	6580	1620	4840	6	0,95	3360	120	2940	5	0,79
	B	61,34	8,95	45,89			21,75	0,72	7,47		
EFORIE SUD	D	9068	4444	4200	8	1,81	4140	2640	1230	6	1,83
	B	68,23	19,79	26,20			230,98	35,08	52,79		
TUZLA	D	5222	2522	2610	6	1,59	10028	5280	4680	6	1,57
	B	148,26	113,46	30,69			65,58	18,26	45,34		
COSTI-NESTI	D	12474	4320	8010	9	1,47	10394	1656	5640	5	0,87
	B	460,21	257,93	106,67			137,93	66,23	64,19		
MANGALIA	D	11050	7306	3540	10	1,37	5264	350	4800	6	0,57
	B	277,22	197,23	42,00			128,20	21,86	106,34		

Les maxima de la densité et de la biomasse de l'hyponeuston sont rencontrés dans le secteur sud, zone où l'influence des effluents continentaux (le Danube et les égouts urbains) est diminuée grâce aux courants. Les valeurs de l'indice de diversité (I.D., d'après SHANNON-WIENER) prouvent aussi une augmentation de la diversité vers le sud. C'est dans la zone côtière (au-dessus de 10 m) qu'on a observé les valeurs les plus hautes de la densité et de la biomasse des organismes de l'hyponeuston, zone où l'apport des zooplanctontes des couches sous-jacentes n'est pas entravé par la hauteur de la colonne de l'eau.

L'hyponeuston de la côte roumaine comprend 14 espèces zooplanctoniques déterminées (NS= nombre des espèces). La moitié sont des formes holoplanctoniques, comme suit : *Noctiluca scintillans* KOFOID & SWEZY, *Pleurobrachia rhodopis* MULLER, *Mnemiopsis leidyi* AGASSIZ, *Penilia avirostris* DANA, *Pleopis polyphemoides* LEUKART, *Pseudevadne tergestina* CLAUS et *Acartia clausi* GIESBRECHT, le reste des organismes méroplanctoniques.

Si, avant 1970, les Monstrillides et le Copépode *Anomalocera patersoni* TEMPLETON constituaient les indicateurs de l'hyponeuston des eaux roumaines de la mer Noire (1,2), les recherches de cette année mettent en évidence leur disparition de cette communauté, constituée aujourd'hui d'espèces communes du zooplancton néritique à côté de méroplanctontes (larves de Polychètes, nauplii et "cypris"de *Balanus*, accompagnés de véligères de *Mya arenaria* L. et de Gastéropodes dans les zones du nord et de *Mytilus galloprovincialis* LAMARCK dans celles du sud, où l'on a trouvé également des larves zoë de *Carcinus* et de *Palaemon*) qui restent les éléments caractéristiques. S'y ajoutent des stades de développement ontogénétique d'*Acartia clausi* GIESBRECHT qui "font palier" dans la couche superficielle des eaux.

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The fin whale and other large pelagic filterers as samplers of *Meganyctiphanes norvegica*

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The study of the population structure and dynamics of Euphausiids is often hampered by the scarcity of samples, due to the fact that these shrimps have a high rate of avoidance of plankton nets. The problem is similar to that of collecting study material of cephalopods, which cannot be obtained by common fishing gear. In the latter case, marine odontocetes, who often are specialized hunters of this prey, are the best samplers (CLARKE, 1986a) and their stomach content, albeit digested, given the tools now available (CLARKE, 1986b), are a very important source of information.

As to solution to the problem of the quantity of material needed to assess length/frequency distribution in Euphausiids, the collections effected by large pelagic filterers may be of great utility. Two cases are possible:

a) freshly ingested Euphausiids which may be directly measured

b) digested prey where some hard remains may be measured and related to total length.

The fin whale, which is frequently encountered during the summer months in the Ligurian Sea (VIALE-PICHOD, 1977) is the most powerful sampler of *M. norvegica* (RELINI ORSI and GIORDANO, 1992). The feces of *B. physalus* which can be dipnetted in surface waters contain in a few ml of volume, in form of isolated mandibles, the equivalent of several hours of work at sea using the 15 feet I.K.M.T. net. To make such material utilizable we have established the total length/mandible length relationship. The shrimps were obtained by a I.K.M.T. haul, from 750 to 0 m (August 1991) and measured from the frontal border to the telson in mm; the mandibles were measured under the stereomicroscope by means of a micrometric ocular lens, in mm, along the axis from the molar process to the opposite tip (Fig.1).

For N = 53 and R = 0.96 the linear regression is:

Total length (mm) = 12,3350899 mandible length (mm) + 5.1071876.

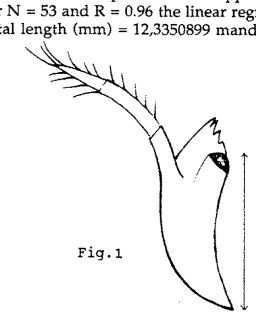

Fig.1

It is interesting to compare the sizes of prey of *Balaenoptera physalus* and the specimens caught by the I.K.M.T. at the same time. Couples of such data (fig. 2 and 3) have been collected in some stations of the Liguro-Provençal basin which were considered "hot spots" for *M. norvegica* (RELINI *et al.*, 1992). The summer samples obtained by the plancton net include two main age groups, each of them formed by several subcohorts. The relative importance of the two main groups varies in different stations (RELINI *et al.*,1992). Similar patterns result from samples of feces of different fin whales.

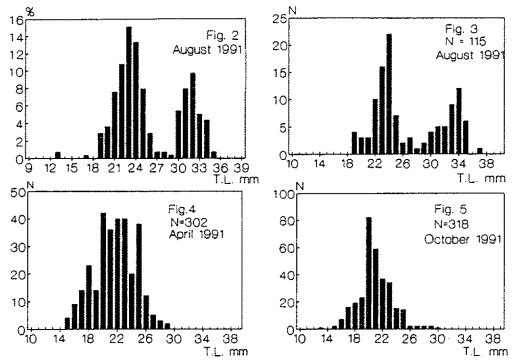

Fig. 2,3,4,5. Length/frequency distributions of *M. norvegica* obtained by I.K.M.T. (Fig.2), by feces of fin whales (Fig. 3 and 4) and by the stomach content of a devilfish (Fig. 5).

Samples collected in temporal sequence are obviously useful for growth assessment. Two examples of length/frequency distributions obtained in different seasons are shown (fig 4-5). The latter represents case a), i.e. *M. norvegica* directly measured from a meal of *Mobula mobular*. This large pelagic filterer was caught by a swordfish driftnet.

Acknowledgment

We thank Dr. L. MONTALDO who has provided us the material of *Mobula mobular*.

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A Summer large scale distribution of pelagic shrimps in the Liguro-Provencal Basin

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Crustacean Decapods are an important component of pelagic food webs. In the framework of a large scale macroplankton sampling in the Western Ligurian Sea aimed at the key species in the diet of large nekton (tuna, swordfish, cetaceans), we describe this taxocenosis in the 0-750 m range.

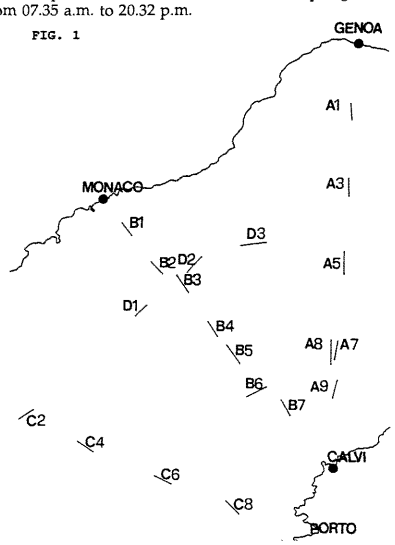
Sampling methods

Over a period of two weeks (August 17 - 29 1991) using the R/V *Minerva* (CNR), an area of 8600 sq. naut. mi. was covered, and 20 sampling stations were located along four transects: A, Genova-Calvi; B, Monaco-Calvi; C, Marseilles-Gulf of Porto; and D, perpendicular to B, from 43.13.89N 07.35.66E to 43.32.63N 08.15.49E (Fig.1). The standard haul for macroplankton, consisted in a oblique tow of a 15 feet open I.K.M.T. (2x2 mm mesh in the cod end), from 750 m to the surface in steps. The haul lasted two hours at a ship speed of about 3 knots. The net opening was calculated to be 17.55 m^2 on analogy with the 3 m I.K.M.T., whose opening is estimated to be 7.8 m^2 (FOXTON, 1969). The amount of filtered water per hour is 97571 m^3. The sampling time (beginning of the haul) ranged from 07.35 a.m. to 20.32 p.m.

Results

A total of 3779 specimens were collected (Table 1) with an average of 183.2 ± 74 per station. The most abundant species were *Gennadas elegans* (39.7%), *Sergestes arcticus* (30.6%), and *Pasiphaea multidentata*, mainly represented by young individuals (13.5%).

FIG. 1



Remarks

1) In the present offshore pool of Decapods the dominance of *G. elegans* is interesting : it represents a common feature with Atlantic areas (FOXTON, 1970, HARGREAVES, 1984). Nearest the coast *S. arcticus* (FRANQUEVILLE, 1971, VU DO, 1981, SARDOU and ETIENNE, 1988), and *P. sivado* (personal observation in the Gulf of Genoa) proved to play this role. Detailed information on distribution, density, sex ratio and size frequencies of *G. elegans* have been given (ORSI RELINI and TARTAGLIA, 1991).

TAB. 1

Stations	Acanthephyra pelagica	Funchalia villosa	Funchalia woodwardi	Gennadas elegans	Pasiphaea sivado	Pasiphaea multidentata	Sergestes arcticus	Sergestes cornutum	Sergestes sargassi	Sergestes vigilax	Sergestes sp.	Sergia robusta	Totals
A1	--	--	--	101	22	9	11	3	1	3	1	--	151
A3	27	--	2	76	39	58	8	6	5	3	--	22	246
A5	--	1	--	38	35	6	15	9	1	2	--	--	107
A7	--	--	--	28	6	7	56	10	3	7	8	--	125
A8	9	--	--	108	55	16	92	23	13	16	--	11	343
A9	--	--	--	70	24	7	31	6	5	1	--	1	145
B1	--	--	--	76	24	30	53	5	1	4	--	--	193
B2	1	--	--	76	30	10	23	1	1	--	1	1	144
B3	--	--	--	1	5	25	49	--	9	1	--	--	90
B4	--	--	--	9	15	7	60	5	6	4	--	--	106
B5	1	1	--	165	17	8	50	3	2	1	--	2	250
B6	--	--	--	21	5	3	28	4	4	3	--	--	68
B7	12	--	--	97	27	6	49	9	1	3	--	6	210
C2	--	--	1	116	30	8	105	3	7	--	--	--	270
C4	--	1	--	114	10	6	189	8	2	6	--	--	221
C6	2	1	--	19	--	2	73	--	3	3	1	--	104
C8	--	--	--	150	19	1	70	17	--	10	--	--	267
D1	2	--	--	46	58	5	63	3	3	--	--	3	183
D2	--	--	--	84	35	11	36	2	5	--	--	--	173
D3	--	--	--	106	54	7	95	4	--	2	--	--	268
	54	4	3	1501	510	232	1156	121	72	69	11	46	3779

2) Besides the listed species, also *Lucifer typus*, *S. mollis* (FRANQUEVILLE, 1971) and *Acanthephyra eximia* (RELINI ORSI, 1973) have been recorded in the area. In particular, this last species is easily found in the Gulf of Genoa when sampling is effected below 1000 m.

3) Given that the vertical distribution of the listed species extends more than 750 m (FRANQUEVILLE, 1971), vertical migrations influences the catches. In particular, a group of "deep species" (*G. elegans*, *S. robusta*, *A. pelagica*, *F. woodwardi*) may be distinguished from the others. The correlation between time of sampling (in a fivepoint scale of light) and numbers of individuals collected in each station was tested for single species and for groups of species. The correlation proved positive for *G. elegans* (P=0.05) and for the above mentioned "deep group" (P=0.01) and absent for the others. In other words, a column of 750 m is probably the suitable sampling range only for the "less deep" species.

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Temporal and spatial distribution of neritic and mesopelagic fish larvae in the Gulf of Kisamos (NW Cretan Sea, SW Aegean Sea)

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The present study concerns with the assessment of the fish larvae composition and their temporal abundance in the neritic and mesopelagic zone. The study area is the Gulf of Kisamos which is connected to the open SW Aegean Sea. Although the total area of the Gulf of Kisamos is rather a small one, it is lined by a narrow continental shelf and an abrupt continental slope. This kind of geomorphological feature is expected to play an important role on the density of neritic and mesopelagic fish larvae, according to YOUNG *et al.* (1986). Relevant information are reported in our previous study (PAPASISSI and LYKAKIS, 1988). Other studies concerning with fish larvae of the Gulf of Kisamos are non-existing.

Day samples were collected from five sites (S1, S2, S3, S4 and S5 stations) of the Gulf of Kisamos in September and November 1988, and February, April, May and July 1989. Samples were taken by double oblique hauls in the upper 50m using a Bongo net with 500µm mesh size. 88 fish larvae species were identified in our samples. The identification was based on ABOUSSOUAN (1964), PAPASISSI and FROESE (1990), and other sources. Among all identified larval fish, 16 species were recorded in abundant densities.

A peak and minimum density of the total fish larvae group occurred in April 1989 (106.9 n.100m^{-3}) and November 1988 (11.7 n.100m^{-3}) respectively (Anova test, $p<0.05$). Density values of fish larvae in other collecting periods were: 15.3 n.100m^{-3} in September 1988, 42.6 n.100m^{-3} in February 1989, 64.11 n.100^{-3} in May 1989 and 42.3 n.100^{-3} in July 1989. Peak densities of fish larvae group coincided with mean maximum biomass of zooplankton (438.6 mg.100m^{-3}) while their minimum abundance occurred when minimum values of zooplankton biomass were recorded (51.2 mg.100^{-3}) (FRAGOPOULU, personal communication).

Higher mean annual densities of fish larvae were recorded at neritic stations S1 and S5 (53.96 and 95.6 n.100m^{-3} respectively), and station S2 (60.77 n.100m^{-3}) at the edge of the continental shelf (200m depth). Lower densities of fish larvae were found at pelagic stations S3 and S4 (at depth >200m) (13.8 and 10.4 n.100m^{-3} respectively). In addition, the diversity of fish larval species was found higher at neritic stations. To justify differences between neritic and pelagic station groups, Anova tests ($p<0.05$) were applied. It seems, that composition and differences of fish larvae assemblage are determined by temporal and spatial factors.

Among all different fish larval species identified in the Gulf of Kisamos, highest mean density values recorded for *Diplodus annularis*, *Boops boops*, *Gobius niger*, *Cyclothone braueri* and *Hygophum* sp.

Neritic and mesopelagic fish larval species were collected at all sampling stations. The following abundant neritic fish larvae were identified: *Crenilabrus* sp., *Chromis chromis*, *Anthias anthias*, *Serranus cabrilla*, *Crystallogobius linearis* and *Sprattus sprattus*.

Similarly, the following abundant mesopelagic fish larvae were recorded: *Ceratoscopelus maderensis*, *Lampanyctus pusillus*, *Lampanyctus crocodilus*, *Diaphus holti* and *Stomias boa*.

Most of the abundant fish larvae showed a well defined seasonal distribution. For example, the following larval fish are encountered in maximum densities in the indicated collecting periods. a) Neritic species: *Diplodus annularis* in April, *Boops boops* in April, *Gobius gobius* in May, *Anthias anthias* in September, *Chromis chromis* in September, *Crenilabrus* sp. in April, *Crystallogobius linearis* in November, *Serranus cabrilla* in July, and b) Mesopelagic species: *Hygophum* sp. in November, *Cyclothone braueri* in September, *Lampanyctus pusillus* in February, *Lampanyctus crocodilus* in April, *Diaphus holti* in February and *Stomias boa* in February. Larvae of *Sprattus sprattus* were found in very abundant densities in April while they are almost missing in the remaining sampling periods.

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Remarques sur le développement quantitatif du Zooplancton de la Mer Noire en face du Delta du Danube

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Le secteur prédeltaïque, importante zone marine du littoral roumain de la mer Noire, s'est trouvé, surtout les deux dernières décennies, sous une surveillance écologique continue de tous les compartiments de l'écosystème. Les observations effectuées pendant la période 1973-1980 sur le zooplancton du secteur marin situé devant les embouchures du Danube ont révélé une augmentation des densités et des biomasses zooplanctoniques, en moyenne de cinq fois, comparativement à la période 1960-1965 (1, 2). Après 1980, dans les eaux cotières de la zone prédeltaïque, le développement explosif de quelques espèces zooplanctoniques a déterminé, specialement en 1981, 1983 et 1985, des biomasses supérieures à la décennie précédente (3).

Nous avons continué les observations saisonnières durant la période 1986-1988, qui s'est caractérisée par des grandes crues du Danube et par des phénomènes nombreux et intenses de floraison; les valeurs moyennes de la densité et de la biomasse zooplanctoniques ont connu une augmentation continuelle, dépassant plus de dix fois celles enregistrées jusqu'en 1980 (en été 1986 les biomasses du secteur Sulina furent huit fois plus grandes que celles déterminées dans ce même secteur en 1976, alors qu'en 1987 et 1988 elles ont augmenté en été de 3-6 fois plus qu'en 1986 (Tableau 1).

Tableau 1. Valeurs moyennes des densités et biomasses zooplanctoniques dans le secteur marin des embouchures du Danube

Radiales	Mois	1986		1987		1988	
		$ind.m^{-3}$	$mg.m^{-3}$	$ind.m^{-3}$	$mg.m^{-3}$	$ind.m^{-3}$	$mg.m^{-3}$
Sulina	avril	2528	29,74	4655	43,10	80899	72,87
	juillet	54943	3671,50	516415	13411,29	345770	21174,50
	septembre	15096	270,17	3824	43,00	7850	71,22
Mila 9	avril	3825	46,08	2865	52,32	161141	219,74
	juillet	49135	4600,67	232343	36067,60	168197	20606,00
	septembre	21087	99,97	11393	101,97	15920	85,32
Sf. Gheorghe	avril	4411	41,00	4585	81,42	19250	86,20
	juillet	182736	13874,50	408164	57940,40	279368	33713,30
	septembre	35901	342,73	66301	795,81	38360	520,71

Il faut remarquer aussi que les quantités du zooplancton ont été pendant ces trois années, dans la zone des embouchures du Danube, jusqu'a huit fois plus grandes que dans les autres aires marines étudiées au centre et au sud du littoral roumain de la mer Noire.

L'analyse quantitative des principaux groupes dans les communautés zooplanctoniques identifiées nous a permis de constater:

- l'importante prédominance numérique et pondérale du cystoflagellé *Noctiluca scintillans*, surtout pendant l'été immédiatement après les poussées phytoplanctoniques (la biomasse maximale en 1987 dans les eaux côtières a atteint 171.218,4 $mg.m^{-3}$); il a représenté pendant ces années, en été, 72-99, 8% de la biomasse totale du zooplancton,
- la croissance continue des biomasses constituées par les Copépodes, dont l'espèce dominante *Acartia clausi* représente plus de 80% de la biomasse des Copépodes,
- les populations des Cladocères dominées par l'espèce *Pleopis Polyphaemoides* ont été moins abondantes comparativement à la décenie antérieure quand *Penilia avirostris* représentait l'espèce dominante parmi les Cladocères,
- l'évolution du peuplement des organismes méroplanctoniques a reflété les changements apparus dans les communautés benthiques de la zone prédeltaïque; si le méroplancton était très abondant ici jusqu'en 1980, conséquence de l'extension des populations du bivalve *Mya arenaria* et de la prospérité des Polychètes sur les fonds sédimentaires de la zone, son importance dans la biomasse zooplanctonique a diminué ultérieurement à cause des mortalités intervenues dans la faune des bivalves, et a été dominée pendant la dernière période par les larves nectochètes des Polychètes,
- la composition spécifique du zooplancton dans ce secteur s'enrichit de formes dulcicoles arrivées avec les masses d'eau douce et qui, parfois, aux grandes crues, ont des populations assez abondantes (en 1988 elles représentaient jusqu'à 50% du total des espèces dans les stations côtières).

Les recherches effectuées ces dernières 15 années dans ce secteur de la mer Noire ont mis en évidence que, parallèlement à l'augmentation des quantités globales de phytoplancton au cours de la décennie 80, les principaux groupes zooplanctoniques ont connu un très grand développement en fonction de l'accroissement de l'eutrophisation, mais seulement un nombre réduit d'espèces - celles caractéristiques des espaces eutrophisés - ont contribué à l'augmentation quantitative du zooplancton enregistrée jusqu'en 1988.

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Solar control upon the phytoplankton in the Black Sea

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Multiannual dynamics of phytoplankton along the Bulgarian Black Sea coast (cells number $10^6/m^3$, biomass mg/m^3) was investigated by us in the period 1954-1990.

During the period 1954-1960 we established a gradual decrease of the phytoplankton biomass of the water area from the estuary of the Danube to the Bosphorus (PETROVA, 1960). The structure of the phytoplankton in the water space has a seasonal characteristic and it is strongly influenced by the temperature, salinity and nutrients content of the sea (PETROVA-KARADJOVA, 1973). During the years 1954-1970 the biomass of diatoms predominated over dinoflagellates (10:1). In the following years 1971-1980 the ratio of diatoms to dinoflagellates changed from 1 to 7 (PETROVA-KARADJOVA, 1984). The average annual biomass of diatoms and dinoflagellates shows that they are opposite, especially in the conditions of the anthropogenic eutrophication after 1970, which is the result of different types of nutrition (fig.1).

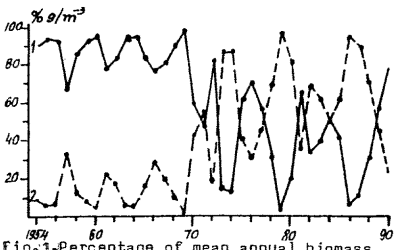

Fig.1.Percentage of mean annual biomass of diatoms(1)and dinoflagellates(2)of the phytoplankton in Bulgarian Black Sea coast

The cyclic influence of solar activity upon the diatoms, which have dual maximum development every 5,5-years in every 11-years cycle of the sun-spots (19th -21st cycles by the Zürich numeration) was proved though statistical and spectral analyses (PETROVA-KARADJOVA, A-POSTOLOV, 1988). An opportunity for prediction was created for the present 22nd cycle, whose maximum was expected in 1990 (SOLAR GEOPHY-SICAL DATA, 1987) and the maximum of the diatoms - in 1991-1992.

The prognosis proved true earlier as the maximum of 22nd cycle began in 1989 (HIRMAN, GREER, SMITH, 1988) and remained at the same level till 1991, but the diatoms predomina-ted even in 1990 with an unequal development.

In the increasing organic pollution after 1970 "red tides" of *Prorocentrum minimum* (Pav.) Schill. appeared (MARASOVIC, PUCHER-PETKOVIC, PETROVA-KARAD-JOVA, 1990) which coincided with the maximum and minimum of the 21st cycle (1979 and 1986). It was found out that this type of influence was valid for the blooms of species, belonging to different taxa (PETROVA-KARADJOVA, 1990).

All the arguments on behalf of the concept of solar control upon the dynamics of the diatoms and other plankton alge are a reason to group the multiannual dynamics of phytoplankton species into periods corresponding to the periods of the solar cycles.

The period from 1956 to 1958 is known to have the greatest variety of species, followed by a depression till 1970, after that there is an increase of the number of species, in the years of the 21st and 22nd solar cycles, excluding the years of the blooms (1979 and 1986) (fig.2). The eutrophication enriches the phytoplankton with new species (now they are more than 200 total in comparison with only 162 in 1957, after the disappearance of the unsteady species in the Bulgarian area.

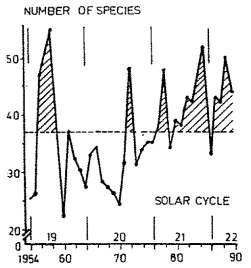

Fig.2.Dynamics of the phytoplankton in the years of solar cycles. Average level of the number of species in the quantitatives samples(---)

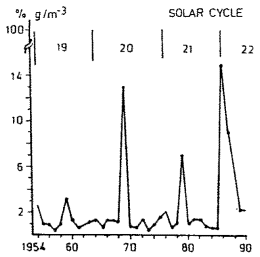

Fig.3.Cyclic dynamic/of the phytoplankton in average annual aspect by 11-years cycles of sun-spots(19-22)

The ratio between average annual biomasses of the phytoplankton along the Bulgarian Black Sea coast during 1954-1990 shows that it has two maximum developments in every 11-years cycles (fig.3): in 1959 (two years after the maximum of the 19th sun cycle, 1957) and in 1964 - in the minimum the 19th cycle; in 1969 (a year after the maximum of the 20th sun cycle, 1968) and in 1976 - in the minimum of the 20th cycle; in 1979 due to increasing organic pollution and "red tides" (in the maximum of the 21st cycle) and in 1986 (in the minimum of the same cycle).

These results prove the role of the solar control upon the multiannual dynamics of the phytoplankton in the Black Sea and give a chance for the prediction of the marine phytoplankton dynamics in the future.

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Evolution du zooplancton des eaux du plateau continental roumain de la Mer Noire au cours de trois décennies

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The paper presents a study on the qualitative and quantitative changes of zooplankton during the 7th-9th decades.

Cette note fait partie d'une étude complète sur le zooplancton de la mer Noire. Les échantillons ont été recueillis par pêches verticales aux horizons 10-0; 25-10; 50-25; 75-50 et 100-75 m (36 cm = diamètre du filet et 200 µ= vide des mailles) entre 1959 et 1986 dans les eaux du plateau continental jusqu'à 100 m de profondeur. En vue de leur interprétation nous avons utilisé la méthode du calcul statistique. Les résultats sont présentés sur le tableau.

Tableau. Moyennes des densités (D) (mille ind. /m³) et des biomasses (B) (g/m³, en poids frais) du zooplancton

Années	Hiver D	Hiver B	Printemps D	Printemps B	Eté D	Eté B	Automne D	Automne B
'70	2,5± 2,0	0,05± 0,04	24,8 ± 148,4	0,33± 1,96	32,9 ± 185,9	1,17± 8,40	27,1± 25,9	0,28± 0,08
'80	8,2± 33,0	0,30± 1,69	39,0 ± 430,1	0,47± 7,26	90,5 ± 1534,22	0,49± 5,13	13,9 ± 76,49	0,18± 1,18
'90	19,8± 99,7	1,68± 8,17	75,7 ± 664,9	1,60± 12,47	98,7 ± 773,0	4,61± 28,70	62,8 ± 377,4	1,91± 15,56

Pendant cette période le zooplancton a subi des modifications d'ordre structurel et quantitatif, sous l'influence des variations annuelles et saisonnières des températures de l'eau, du contenu en sels biogènes et corrélativement du phytoplancton. Dès les années 70 ce dernier facteur s'est manifesté puissamment, en provoquant des développements massifs de certaines espèces, mais aussi la diminution ou même la disparition d'autres (PORUMB, 1989 a et b).

La saison biologique hivernale commence sur notre littoral au mois de décembre et se prolonge jusqu'au début du mois de mars. Les températures basses de l'eau de surface (1-3°C pendant les hivers durs, 4-8°C pendant les moins sévères) provoquent le ralentissement des processus biologiques et la diminution en nombre d'espèces et en individus du zooplancton.

Les données montrent la croissance des densités et des biomasses totales du zooplancton du commencement vers la fin de la période des recherches. Pendant les hivers de la 8-ème et la 9-ème décennies la croissance des densités a été respectivement de 3 fois et de plus 8 fois; l'augmentation des biomasses a été plus de 6 fois durant les années 70, jusqu'à 34 fois pendant les années 80.

Noctiluca scintillans est l'espèce la plus importante de la zoocoenose. Ses densités ont augmenté à peu près de 70 fois des années 60 aux années 80. Les populations des Copépodes ont grandi à peu près 2 fois durant les deux premières décennies, mais ont diminué de plus de 4 fois durant la dernière. *Acartia clausi, Oithona nana et Pseudocalanus elongatus* ont eu une évolution analogue à celle du groupe entier. Les méroplanctontes (larves de Bivalves et de Cirripèdes) ont toujours évolué identiquement aux Copépodes. Seuls les Tintinnides et les Rotifères ont été nombreux pendant les hivers des années 80.

Au printemps, les températures des eaux oscillent d'habitude entre 12-14°C, rarement entre 16-18°C. En rapport avec ce facteur, l'extension de la période hivernale de développement du phytoplancton (Diatomées) assure des conditions favorables à la reproduction et à la croissance des populations de Copépodes et du méroplancton. En mai *Pleopis polyphemoides* et *Centropages ponticus* font leur apparition. Au voisinage des tuyaux d'adduction en mer des eaux usées prolifèrent les Rotifères (g. *Synchaeta*).

Pendant les années 90 *Noctiluca* a représenté 85% de la biomasse du zooplancton. Les Copépodes ont montré une régression pendant les années 70 et 80 (respectivement à peine 0,6 et 0,5 de la densité de ces crustacés des années 60). Leur évolution a été dictée par *A. clausi*, l'espèce la plus abondante de la zone. Les Cladocères ont évolué à un niveau presque constamment réduit, tandis que le méroplancton s'est caractérisé par la décroissance des populations pendant les dernières décennies. Les Rotifères et les Tintinnides ont évolué pendant les années 90 avec des populations très nombreuses en cette saison.

En été, le réchauffement des eaux de l'horizon supérieur (16-25°C) et le développement accentué du phytoplancton (Dinoflagellés) conditionnent l'évolution du zooplancton.

Pendant la 9-ème décennie la croissance des quantités du zooplancton a été particulièrement intense. *Noctiluca* est restée l'espèce dominante, ses populations étant 5 fois plus nombreuses par rapport à celles des années 1959 à 1969. Le rôle des Copépodes a grandi aussi, *A. clausi* ayant les populations les plus nombreuses. Les méroplanctontes ont eu une évolution plus ou moins insignifiante du point de vue quantitatif. Ont fait exception les larves des Polychètes qui furent plus nombreuses pendant la 9-ème décennie. Les Rotifères ont manifesté de vraies invasions, les populations étant 50 fois plus importantes que celles des deux premières décennies.

En automne, le refroidissement des eaux de surface (de 20°C en septembre à 8-9°C en novembre) détermine une régression des populations zooplanctoniques. Pourtant, les "floraisons" répétées de *Noctiluca* ont eu comme résultat la croissance des quantités du zooplancton pendant les années 80. Les Copépodes ont développé rapidement leurs populations pendant ces dernières années, devenues 3 fois supérieures à celles des années 70. On a observé également une croissance marquée des populations de larves de Bivalves, de Cladocères, de Rotifères et d'*Oikopleura dioica*.

En conclusion, le zooplancton détient un rôle quantitatif important dans l'écosystème pélagique de nos eaux marines. Ce rôle est devenu plus important pendant les années de la dernière décennie, avec un développement quantitatif plus élevé que celui des années 70 et 80. Les altérations du milieu marin, conséquence de la puissante eutrophisation des eaux, sont la cause des transformations rapportées ci-dessus.

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Larval fish aggregation areas in the Catalan coast associated with mesoscale hydrographic structures

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The dominant feature of the physical oceanography of the Catalan coast (Northwestern Mediterranean) is the presence of a permanent shelf-slope front (FONT *et al.*, 1988). The density gradient of the front is mainly associated with salinity differences. The slope water is characterized by salinities higher than 38.0, while the shelf water is less saline because of the influxes of inland water, and spatial and seasonal variability is high (see MASO and DUARTE, 1989).

The mesoscale spatial distribution pattern of fish larvae on the Catalan coast follows certain well defined overall patterns. The most salient feature is that the highest concentrations (800-5000 larvae 10m^{-2}) are located over the edge of the shelf (see Fig. 1 corresponding to month of April 1983), because of the combined presence of the larvae of offshore species with the larvae of inshore-dwelling species in this region. This phenomenon of concentration seems to be related to the presence of the shelf-slope front. The front could act as a barrier to the dispersal of the coastal species offshore and, at the same time would favours the transport of mesopelagic fish larvae over the shelf. It is interesting to note the large concentrations of these larvae over the shelf (>100 larvae 10 m^{-2}) and occasionally close inshore, specially between the two northern canyons because of their significant role in the deflection of the southward current, inducing the advection of offshore waters towards the coast (MASO and TINTORE, 1991).

Mesoscale physical structures, can modify the general patterns observed in the larval distribution. The presence of inland fresh waters over the shelf may, on occasion, rapidly alter hydrodynamic conditions in the area, thereby affecting the structure of the epipelagic larval fish community.

In June 1983, there was a large outflow of inland fresh waters from the Rhône River (CASTELLON *et al.*, 1985) giving rise to a surface plume of freshwater (salinity reached a minimum of 29.5 % in the centre of the plume) with a distinct haline front at its southern edge. Large number of species (18) and individuals (around 1 000 larvae 10 m^{-2P}) were found along the southern edge of the plume in association with the haline front (Fig. 1), whereas, with the exception of certain species, larval fish concentrations in the area covered by the plume tended to be considerably lower than in the rest of the area.

In May 1983 an intense inverted density front was detected in the central part of the studied area originated by the presence of warmer and less saline water over the slope. A pronounced temperature front followed the shoreline, with the combined effects of temperature and salinity leading to the formation of a strong inverted density front. In this instance the density gradient confined larve in the inshoremost region (Fig. 1). This was the result of the combination of low abundance at the offshore stations (<50 larvae 10 m^{-2}) and exceptionally high abundance values inshore (>1000 larvae 10 m-2).

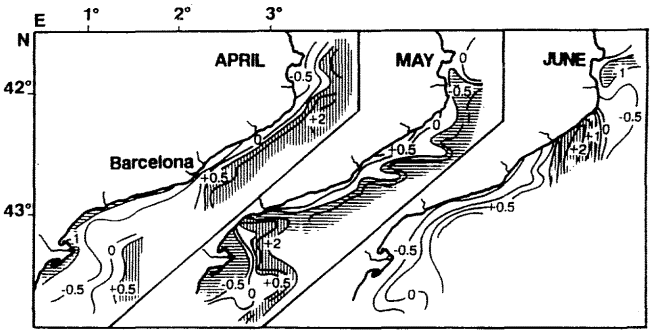

Fig. 1 A principal component analysis (PCA) was applied for each month in order to obtain an objective description of the distribution pattern of the larval population. PCA was performed on the species correlation matrix after smoothing of the species abundance data by a logarithmic transformation. The spatial plot of the sample scores for the first factor obtained in the PCA of April, May and June is presented in figure 1. In the three months, the most positive values (vertical hatched areas) correspond to areas with highest number of species and individuals, whereas the negative values correspond with lower concentrations of individuals (horizontal shaded areas).

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Extension de la banque de données MEDIFAUNE au zooplancton méditerranéen

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La banque MEDIFAUNE (7) propose un ensemble de données factuelles sur la faune marine méditerranéenne. La banque concerne actuellement 5.366 espèces et 1.903 espèces supplémentaires doivent être saisies.

BIOBANK est le logiciel de saisie, de gestion et d'interrogation associé à MEDIFAUNE. Ses commandes permettent de questionner la base documentaire établie originellement sur des fiches.

Pour introduire les animaux holoplanctoniques dans la banque, il a fallu créer de nouvelles fiches comprenant des rubriques adaptées au zooplancton. Pour chaque espèce figurent, outre la position systématique (nomenclature), des informations sur la taille de l'adulte, sa répartition géographique méditerranéenne et mondiale, sa répartition bathymétrique ainsi que des données biologiques et écologiques de référence.

Les formes méditerranéennes de six groupes zooplanctoniques ont fait l'objet d'un recensement exhaustif: sous-classe des Copepoda, ordre des Siphonophora, phylum des Ctenophora, phylum des Chætognatha, classe des Thaliacea et classe des Appendicularia.

1. Copepoda.- En Méditerranée, 496 espèces pélagiques ont été recensées et entrées dans la banque. Un certain nombre, le plus souvent des espèces côtières *(Acartia clausi, Euterpina acutifrons* et *Temora stylifera)* sont bien connues (13) ou ont fait l'objet de travaux approfondis sur leur répartition bathymétrique, leur biologie et leur écologie; d'autres sont des espèces rares, parfois récoltées en un seul exemplaire *(Ratania flava)* et sur lesquelles les données biologiques restent inexistantes. La bibliographie relative à chaque espèce peut donc varier de plus de 50 références, pour *Temora stylifera* par exemple, à moins de 5 pour les espèces rares. Un répertoire mondial préliminaire est dû à RAZOULS (11)

2. Cnidaria et Ctenophora.- L'ordre des Siphonophora est constitué de 3 sous-ordres: Cystonectae, Physonectae, Calycophorae, dont 52 espèces sont présentes en Méditerranée (respectivement 2, 13 et 37 espèces dans les 3 sous-ordres) sur environ 150 espèces mondiales. Dès révisions récentes ont été publiées par CARRE et CARRE (1) et MACKIE *et al.*, (9).

Le phylum des Ctenophora comprend 7 ordres dont 5 seulement seraient représentés en Méditerranée: les Cydippida, les Thalassocalycida, les Lobata, les Cestida et les Beroida, avec respectivement 13, 1, 3, 1, 3, espèces et 2 *species inquirendae*, soit 23 espèces méditerranéennes sur environ une centaine d'espèces mondiales. Une revue a été publiée par HARBISON et MADIN (8).

3. Chætognatha.- Le phylum des Chaetognatha rassemble une centaine d'espèces, planctoniques pour la plupart. Elles se répartissent en 3 ordres, selon l'absence (Aphragmophora) ou la présence de muscles transversaux, soit dans le tronc seulement (Monophragmophora), soit à la fois dans le tronc et le segment caudal (Biphragmophora). En Méditerranée, les Chæto-gnathes sont respectivement représentés par 15 espèces planctoniques (des genres *Sagitta, Krohnitta* et *Pterosagitta)*, 3 benthiques (du genre *Spadella)* et une bentho-pélagique (du genre *Archeterokrohnia)*. La présence de l'espèce planctonique *Eukrohnia hamata* (Monophragmophora) demande à être confirmée. La découverte des espèces bentho-pélagiques ou benthiques profondes et celle des formes cavernicoles étant récente (2), le nombre des Chaetognatha méditerranéens augmentera certainement de quelques unités dans les prochaines années.

4. Urochordata.- Les Urochordata (Tunicata) sont représentés dans le plancton par la classe des Thaliacea et par la classe des Appendicularia.

Les Thaliacea comprennent trois ordres: les Pyrosomida avec une seule espèce méditerranéenne; les Salpida avec 14 espèces méditerranéennes dont 10 ont une réelle importance numérique dans les échantillons planctoniques; les Doliolida avec 5 espèces communes sur la dizaine de formes mentionnées en Méditerranée.

Les Appendicularia comprennent trois familles: les Oikopleuridae avec 1 2 genres dont 6 méditerranéens; les Fritillariidae avec 3 genres, tous présents en Méditerranée; les Kowalevskiidae avec un genre unique présent en Méditerranée (3, 4). Au total, 69 espèces mon-diales, dont 35 en Méditerranée, sont actuellement connues ou en cours de description. Dans 250 prélèvements quotidiens à Villefranche-sur-mer, étalés sur l'année 1972, 5 espèces repré-sentent 89 % des Appendiculaires récoltés. Il s'agit de *Fritillaria borealis f. typica* (28%), *Oikopleura longicauda* (18,5%), O. *dioica* (17%), O. *fusiformis* (14%) et *F. pellucida* (11 %).

La banque MEDIFAUNE est en constante évolution. En ce qui concerne le zooplancton holoplanctonique, les Hydromedusae, Cladocera, Ostracoda et Euphausiacea seront bientôt inventoriés. Depuis peu, elle peut aussi être consultée, en France, sur MINITEL par appel du 36-15 avec le code LISAN*MEDIFAUNE.

La banque est aussi le reflet de l'état actuel de nos connaissances. Il est intéressant de comparer son contenu à celui des derniers ouvrages de référence sur le zooplancton méditerranéen permettant une identification des espèces. Par rapport aux faunes existantes (3, 12) et au Manuel de Planctonologie méditerranéenne (14), on constate une augmentation significative du nombre d'espèces signalées en Méditerranée comme l'indique le tableau suivant :

Groupes	Copepoda	Siphonophora	Ctenophora	Chaetognatha	Thaliacea	Appendicularia	Total
MEDIFAUNE (1992)	496	52	23	20	31	35	657
Ouvrages de référence	369 (11)	41 (14)	14 (14)	17 (14)	18 (14)	34 (9)	493
Nb. d'espèces supp.	127	11	9	3	13	1	164
% d'accroissement	34,4 %	27 %	64 %	17,6 %	72 %	3%	33 %

Cet accroissement du nombre d'espèces holoplanctoniques récoltées en Méditerranee est d'autant plus remarquable qu'il est à rapprocher de l'étude effectuée à partir d'un effectif de 4420 espèces benthiques méditerranéennes (6) qui ne montre qu'un accroissement global de 20% au cours des 40 dernières années.

Les nouveaux moyens d'observation et de prélèvements non destructifs utilisés à partir de submersibles habités devraient encore accroître ce nombre (5, 10).

Ainsi, bien que conçue pour permettre un inventaire informatisé exhaustif et un suivi permanent de la biodiversité des organismes méditerranéens, MEDIFAUNE peut aussi être à l'origine de nouveaux ouvrages de référence dont le besoin se fait sentir 35 ans après la parution du Manuel de Planctonologie méditerranéenne.

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Light attraction of bentho-planktonic assemblages in a shallow *Posidonia oceanica* prairie

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Light is generally considered as one of the most important factors affecting the vertical distribution of zooplankton. Previous studies have analyzed the phototactic responses of zooplankton to an artificial light source in the laboratory (CHAMPALBERT, 1973; FORWARD, 1986). In contrast, the evidence concerning the influence of artificial light in natural habitats remains scarce (KAWAGUCHI *et al.*, 1986).

It is well established that certain benthic organisms can temporarily join the planktonic community under the influence of light. In fact, FORWARD (1988) has proved that light is an important external factor affecting diel vertical distribution, because the migration of these organisms usually corresponds to the underwater light intensity change that occurs at sunrise and sunset.

The goal of the present study was to determine the influence of artificial light on the superficial and nocturnal bentho-planktonic fauna by comparing samples collected in natural conditions (nights of new moon) and after switching on a white light.

The sampling device consisted of a centrifuge pump and a halogen lamp (100 w) placed at a constant depth of 0.5 m, generating a directional light cone into the water column. Two samples were obtained: one in the presence of white light and the other in darkness. In each sample, water was pumped during 4 minutes at a rate of 25 l per minute and filtered througn 69 µm filters to collect organisms. The use of 69 µm filters results in a high diversity of organisms collected without discriminating those of smaller size. Sampling in the white light condition commenced 20 minutes after the lamp was turned on.

The collected organisms were fixed in a 4% formaldehyde solution buffered with borax. All the organims in the samples were counted. Abundances are expressed in individuals/100 l.

This study was carried out in July 1991, in a *Posidonia oceanica* prairie located in a shelter and shallow area (- 5 m) off Chafarinas Island (North Africa, Western Mediterranean). It is a dense prairie (600 shoots/m^2) of uniform topography.

In darkness 398 ind./100 l were collected, belonging to the following groups (Fig. 1): protozoa (tintinnids and foraminifera), cladocerans, copepods (no Pontellidae), cirripede nauplii, veliger larvae, the chaetognath *Sagitta* sp. and appendicularians. In contrast, in the white light condition 1.053 ind./100 l were collected, which belong to the hyperbenthic fauna (polychaetes, isopods, cumaceans, amphipods, mysids and ostracods cypridiformes) and to the zooplankton (copepods Pontellidae, stomatopods and decapod larvae) (Fig. 2).

All organisms collected in darkness were typically planktonic, with a predominance of copepods closely followed by veliger larvae. This cluster of organisms represents the characteristic assemblage found under natural night conditions. On the other hand, under artificial illumination a positive reaction to the light was observed. This resulted in the collection of bentho-planktonic and planktonic organisms that are known to exhibit positive phototaxis (CHAMPALBERT, 1973; FORWARD, 1986). The most abundant fractions in this contingent were the heteronereid polychaetes and decapod larvae.

Some organisms were collected under both conditions (light and darkness) (Fig. 1 and 2): copepods (no Pontellidae) and decapod zoea. However, copepods (no Pontellidae) showed a preference for darkness (typically holoplanktonic) whereas decapod zoea were more abundant under white light (positive phototaxis).

Fig. 1
Darkness

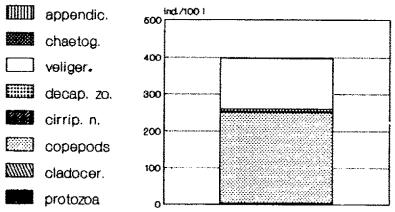
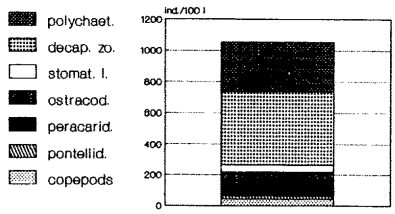


Fig. 2
Light



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Phytoplankton of Vistonis Estuary, Thrace, Northern Greece

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The phytoplankton seasonal variation and community structure have been studied for the first time in Vistonis Estuary, Thrace, N. Greece. Vistonis is a shallow coastal embayment which supports fisheries and is protected by the Ramsar International Treaty for Waterfowl Habitat. Sampling was performed monthly in the area from November 1983 to October 1984 at five sampling stations (Fig. 1). Mean monthly salinity ranged from 0.56 ± 0.3 % in May to 8.95 ± 3.7 % in October, when the longitudinal salinity gradient at the 3 m depth was 0.88 % km/1. The vertical stratification was stronger near the mouth (station 4), where in October the surface to bottom salinity difference reaced 10.5 % .

Chlorophyll-a concentrations showed a marked seasonality too (Fig. 2a); the annual maximum (August 86.0 µg/1) was 144 times higher than the annual minimum (January 0.6µg/1). A horizontal gradient was observed, the mean annual concentration at the head (station 1) being 24.1 µg/1 (2.4 times the corresponding mean value 10.1 µg/1. in the other stations). A strong vertical stratification of chlorophyll-a was observed near the head (station 1) during the warm period (May to October). The mean surface value was 54.9 µg/1 and the mean bottom value was 39.0 µg/1 (YIANNAKOPOULOU, 1989).

The seasonal variation of the total phytoplankton cells was similar to that of chlorophyll-a (Fig. 2b). A highly significant correlation (at the 1 % level) was found to exist between these two phytoplankton biomass parameters, a fact not always holding for similar data from other Mediterranean locations (IGNATIADES *et al.*, 1985).

Cyanobacteria dominated the phytoplankton community most of the year with micro- and nano- sized representatives (Fig. 2c). In September, when a secondary chlorophyll-a peak was observed, Cyanobacteria corresponded to the 97.5% of the total phytoplankton community mainly with the species *Lyngbya limnetica, Anabaena spiroides, Merismopedia punctata* and *M. glauca*. However, Cyanobacteria were partially responsible for the annual chlorophyll-a peak observed in August. This peak consisted of 62 % Cyanobacteria and about 48 % of unidentified µ Flagellates about 1-2 µm in size.

Diatoms were observed in most of the samples; at their annual peak in May, (Fig. 2c) they corresponded to almost half of the total community with species belonging mainly to Pennates. A secondary Diatom peak observed in June was almost entirely due to small centric Diatoms identified as *Cyclotella* spp and *Thalassiossira* spp. up to 7 µm in size.

Two annual peaks of Chlorophyceae were observed in December and January but their percentage in the total phytoplankton community never exceeded 34 %. A small coccoid form up to 5 µm in size, of uncertain taxonomy belonging probably to Chrysophyta was observed mainly in the winter and spring samples corresponding to almost 72 % of the phytoplankton community in March, when fresh-water conditions prevailed. Finally, Dinoflagellates *(Peridinium* spp) were observed only in certain summer samples at the estuary mouth.

The spatial variation of salinity was reflected in the phytoplankton community structure. The percentage of major phytoplankton groups in 1 m depth is shown in Fig. 4 for two characteristic months: May (annual salinity minimum) and October (annual salinity maximum).

The high chlorophyll-a value and cell numbers and the phytoplankton community structure, spatial and seasonal variability, presented in this work, along with the high turbidity, the dissolved oxygen stratification, the high nutrient concentrations and the strong fluctuations presented elsewhere (YIANNAKOPOULOU, 1990 and 1991) confirm the eutrophic conditions in Vistonis and point out to the different character of brackish semi-closed waters as compared to the Mediterranean Sea environment.

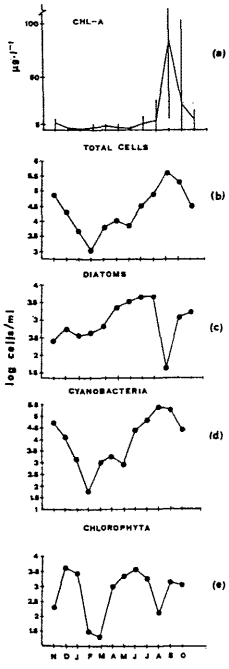

FIG.2

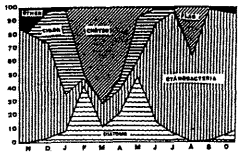

FIG.3

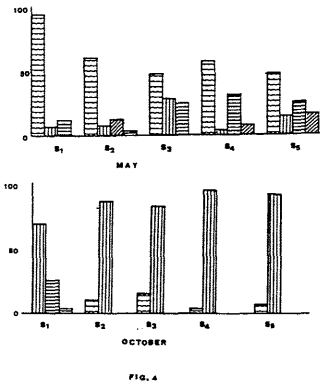

FIG.4

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Phytoplankton Biomass and diversity index in the Western Harbour of Alexandria, Egypt

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The Western Harbour is subjected to large amount of untreated domestic, industrial and agricultural waste water discharged daily which altered its water quality. The phytoplankton standing crop attained its maximum annual average in the surface water (4.7 x 10^6 cells. l^{-1}) more than the adjacent area. Sixty eight species were recorded belonging to a wide ecological spectrum extending from typical fresh-water (23 species) to typical marine forms (45 species) often found side by side. However, very few of them formed the main bulk of the community: *Cyclotella meneghiniana, Nitzschia delicatissima, Prorocentrum cordatum* and *Euglena granulata*. Regarding the seasonal variations, heavy blooms of phytoplankton standing crop were observed in June and less so during August and October. The distribution of the dominant species differed from one month to the other.

Chlorophyll-a content ranged from 0.2 to 11.0 mg/m^3 in the surface water with an annual average of 4.2 mg/m^3. This value is lower than the records of El. Mex Bay.

The estimated diversity reflects a reverse relationship to the degree of dominance of the species recorded than the number of species or standing crop.

The Western Harbour of Alexandria is the main trade harbour in Egypt. It is elliptical in shape with a length of 7.0 Km. The depth of the water varies from 5.5 to 16.0 meters. It occupies a surface area of bout 13 km^2, partially divided into an inner and outer part with a total length of 9875 m as quays which can station a maximum of 62 ships at one time.

Previous studies were concerned with the geochemical, hydrographic nature and trace metals concentration. The present investigation is the first study on the phytoplankton standing crop as well as community composition and distribution of the different species in relation to the prevailing environmental conditions in addition to diversity index.

Water and phytoplankton samples were collected from eight stations, representing the different habitats of the harbour. Samples were taken from the surface layer, 5 meter depth and near the bottom at bimonthly intervals during the year 1989, by means of a plastic Ruttner water sampler. Secchi-disc readings, temperature, pH value, total alkalinity, salinity, dissolved oxygen, oxidizable organic matter and the nutrient salts were measured and discussed earlier by ZAGHLOUL and NESSIM (1991). Measurements of the phytoplankton standing crop were carried out by the sedimentation method and the samples were preserved in 4% neutral formalin. The different species were identified and counted as cells per liter. Chlorophyll-a was determined spectrophotometrically according to STRICKLAND and PARSONS, (1972), and the result is expressed as mg/m^3. Species diversity was calculated according to the equation of SHANNON and WEAVER (1961) on a computer, using Primary Program as well as cluster and MDS diagram during the training workshop on the statistical treatment and interpretation of marine community, Alexandria, Egypt, 9-19 December 1991.

The phytoplankton standing crop showed a much higher annual average in the surface water (4.7x10^6 cells.l^{-1}) as compared with the adjacent area of El-Mex region (DORGHAM *et al.*, 1987). But it is similar to that recorded in the Eastern Harbour which averaged 4.1x10^6 cells.l^{-1} (ZAGHLOUL & HALIM, 1990) . This is also the case of many harbours impacted by the domestic discharge and industrial effluents (RAO & MOHANCHAND, 1988).

The harbour can be differentiated into three main habitats according to the degree of contamination. The first region is represented by El-Boughaz area (Sts. IV & V) which sustained the highest annual averages of 6.7x10^6 and 6.5x10^6 cells.l^{-1} at the two stations respectively. This is attributed to the eutrophication effect of brackish water introduced into the harbour from El-Mex region. The highly polluted area is located at the eastern side (Sts VI, VII & VIII) and it sustained the highest oxidizable organic matter and nutrient level which correspond to lower values of dissolved oxygen, salinity and Secchi-disc readings (ZAGHLOUL & NESSIM, 1991) as well as lower phytoplankton standing crop (annual averages of 2.5x10^6, 3.0x10^6 & 3.3x10^6 cells .l^{-1} at stations VI, VII & VIII respectively). The western sector (Sts I, II & III) is the least polluted region and it harboured relatively high counts of phytoplankton (annual averages of 5.4x10^6, 5.1x10^6 & 4.7x10^6 cells l^{-1} at station I, II & III respectively).

As regards to their seasonal variations, heavy blooms of phytoplankton standing crop were observed in June and less so during August and October. The first two months were characterized by a pronounced increase in water temperature (26.5 & 28°C), high stability, high pH value, silicate content and concentration of dissolved oxygen as well as lower values of water salinity, Secchi-disc readings and nitrate concentration (ZAGHLOUL & NESSIM, 1991) and also greater species diversity. Generally, the dominant species differed from one month to the other . Thus, the June and August bloom were dominated by *Cyclotella meneghiniana* and less so *Nitzschia longissima* and *Prorocentrum cordatum*. The October bloom was mainly due to *Nitzschia delicatissima, Prorocentrum cordatum* the main plankter in February; this coincided with higher phosphate content which had positively strong correlation with the species counts (r=0.94), while *Euglena granulata* prevailed in April.

The concentration of surface chlorophyll.a (phytoplankton biomass) ranged from 0.2 (St. VIII, February) to 11.0 mg/m^3 (St.I, August) with annual average of 4.2 mg/m^3. This value is lower than the records of El. Mex Bay (DORGHAM *et al.*, 1987). On the average basis, the highest value was recorded in December (6.23 mg/m^3) and less so during April (4.8 mg/m^3), June (4.92 mg/m^3) and August (5.16 mg/m^3) . As for the stations, the maximum chlorophyll-a content was recorded at station I (5.93 mg/m^3) and minimum value at station VIII which is more polluted (2.87 mg/m^3). In comparison between the phytoplankton counts and its biomass (Chl.a), there is a reversable relationship. This is due to the volume (size) of the dominant species which often differ from one month to the other as mentioned previously. This result corresponds with the finding of ZAGHLOUL, 1985.

The estimated diversity reflects a reverse relationship to the degree of dominance of the species recorded rather than the number of species or the magnitude of standing crop. Such conclusion is clearer in the surface water of the harbour throughout the year. For example, the highest average diversity value was recorded during both April and August and this coincided with lower phytoplankton density in April rather than August. These two months showed also big differences in the number of the recorded species (34 & 28 species respectively). This is attributed to the dominance which was shared by several species. On the other hand, the lowest average diversity values were recorded during February and October. In spite of the wide difference in the phytoplankton standing crop, the community composition was mainly represented by only one significant species; *Prorocentrum cordatum* formed 91% of the total community in February and *Nitzschia delicatissima* contributed 84% in October.

In conclusion, biological indices of eutrophication in the Western Harbour are: a heavy phytoplankton standing crop particularly in the surface layer, the presence of allochtonous fresh-water species in abundance, with a high percentage of *Eugelena granulata*.

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Radioactivity levels in fish, shellfish, algae and seagrass collected from the Eastern Black Sea coast of Turkey, 1992

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Following the Chernobyl accident, radioactive contamination in the Black Sea environment of Turkey has been detected in fish, algae and shellfish (TOPCUOGLU *et al.*, 1988), (GUVEN *et al.*, 1990), (TUNCER and BAYSAL, 1990). In this study we report data obtained on radioactivity levels in fish, shellfish, algae and seagrass collected from the Eastern Black Sea coast of Turkey in 1992. For fish and shellfish, muscle and soft tissues, respectively, were sampled. The samples were dried, powdered and analyzed by a gamma spectrometer (Tennelec) coupled to a high purity Germanium detector.

The results are given in Table 1. Radioactivity was detected in all samples and varied with species and location. The measured levels of Cs-134, Cs-137 and K-40 ranged between 1-5, 5-21 and 600-3725 Bq/kg dry weight, respectively.

TABLE 1. Radioactivity levels in Selected Samples collected in 1992.

SAMPLES	Cs-134	Cs-137	K-40
	(Bq/kg dry)		
FISH			
Trachurus mediterraneus	1	5	605
Engraulis encrasicholus ponticus	4	13	900
Mugil saliens	2	11	653
Merlangus merlangius euxinus	4	12	965
Alosa fallax	1	7	1485
SHELLFISH			
Mytilus galloprovincialis	2	11	1840
Patella vulgata	4	10	893
Rapana thomasiana	2	9	600
ALGAE			
Ulva lactuca	5	19	2080
Enteromorpha sp.	3	13	2260
Cystoseria barbata	3	7	1130
SEAGRASS			
Zostera marina	5	21	3725

Comparison of the 1992 results with those of the our earlier study showed that the levels of radiocesium in fish, shellfish and algae have decreased considerably. For example the amounts of Cs-137 in *T. mediterraneus*, *M. saliens* and *M. galloprovincialis* were 47, 107 and 130 Bq/kg, respectively, in 1990 and only 5,11 and 11 Bq/kg in 1992. Also Cs-137 in *Enteromorpha sp.* and *C. barbata*, 35 and 27 Bq/kg in the earlier survey, had decreased to 13 and 7 Bq/kg. The highest concentrations of Cs-137 were found in *U. lactuca* and *Z. marina* while the lowest activity was detected in *T. mediterraneus* and *A. fallax*. It appears from our data that Chernobyl-derived radiocesium has diminished considerably in Turkish coastal waters during the period 1990-1992.

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Determination of gas transfer coefficients in different environments of the Mediterranean Sea using the radon deficit method

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Increasing levels of atmospheric carbon dioxide from the burning of fossil fuels and changes in land uses may result in significant climate changes in the next century. Comprehension of the mechanism governing the uptake of CO_2 in the ocean is crucial to assess the impact on climate of atmospheric CO_2 concentration changes. With regard to the evaluation of CO_2 transfer at the air-sea interface, some uncertainties over all still exist in the dependence of the gas transfer coefficients on meteoclimatic parameters.

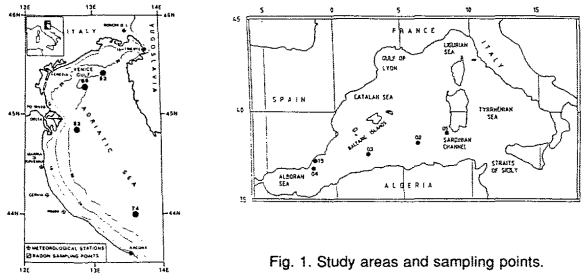

Fig. 1. Study areas and sampling points.

The disequilibrium between radon and its parent radium in the wind-mixed layer provide a widely used method for the direct calculation of the gas transfer coefficients (BROECKER and PENG, 1974). At present, a relevant number of estimations of gas exchange rates are available for the world oceans, but very few measurements have been carried out in the Mediterranean Sea.

This paper discusses the use of the radon deficit method for the calculation of gas transfer coefficients in two different Mediterranean environments: the shallow Northern Adriatic Sea and the deep Western Mediterranean between Southern Sardinia and the Gulf of Vera (Murcia, Spain) (Fig.1).

The radon deficit was estimated through the analysis of vertical profiles of radon and radium in and below the mixed layer. Five to eight samples were collected at every station. ^{222}Rn was stripped from seawater by helium carrier and adsorbed on an activated coconut charcoal cold trap. Radon was then eluted with toluene and measured directly onboard by liquid scintillation (QUEIRAZZA *et al.*, 1991). Radium analyses were performed on land on the same samples, after radon ingrowth, by the same method. The meteorological parameters were measured either onboard or by the Italian Air Force Meteorological Network in coastal stations close to the sampling points.

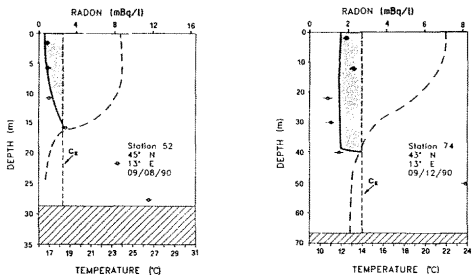

Fig.2 - Vertical profiles of ^{222}Rn (—) and temperature (---) at two stations in the Adriatic Sea. C_E=^{226}Ra concentration.

In Fig. 2 the vertical profiles of ^{222}Rn are shown for two stations in the Adriatic Sea. For this area, the calculated gas transfer coefficients range from 4 to 7 m.d-1 for wind speeds of 2-3 m.s-1. These data are in the range of those observed for other marine environments (PENG *et al.*, 1979). However, when considering the low wind speed during the period of sampling, these gas transfer coefficients appear higher than those resulting from laboratory experiments or other field surveys. Preliminary results obtained in the other study area (SW Mediterranean) in similar meteoclimatic conditions confirm that the gas transfer coefficients calculated for the Adriatic Sea are higher than those obtained for deep-sea environments. MURPHY *et al.* (1991) have shown that large differences are noted among experimental data obtained in different environments when gas transfer velocity is correlated for wind velocity. This difference is probably related to the fact that wind speed is not the best correlating parameter for gas transfer coefficients and that wave parameters have to be taken into account in order to make an accurate prediction of gas fluxes at the air-sea interface.

Aknowledgements

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Accumulation and retention of ^{137}Cs in selected marine biota from Turkish waters

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At present the question of radioactive pollution along the coast of Black Sea and Marmara Sea of Turkey is considered very important. Radioactivity levels in these seas have increased from the Chernobyl accident and other uncontrolled releases of certain radioactive waste materials (TOPCUOGLU *et al.*, 1990; GUVEN *et al.*, 1990). In addition, the Danube river and others flow into this sea system carrying contaminated waters from countries with large nuclear facilities.

The radionuclide ^{137}Cs has been the major contributor to contamination of the marine environment after the reactor accident at Chernobyl, and it is also the main long-lived component of radioactive fallout which has arisen from nuclear weapon tests. In addition, ^{137}Cs enters the marine environment from nuclear reactors. The Marmara and Black Sea have been likewise influenced to some degree by all these sources.

The macroalgae (*Enteromorpha linza*), polychaetes (*Nereis diversicolor*), isopods (*Idothea primastica*), brown shrimp (*Crangon crangon*) and fish (*Proterorhinus marmoratus* and *Syngnathus abaster*) were used in laboratory studies to assess the biokinetics of ^{137}Cs. The objectives of the studies were (1) to study the behaviour of ^{137}Cs in marine biota under varying environmental parameters, and (2) to obtain better bioindicator organisms for use in our monitoring studies.

The test organisms were obtained from the Kucukcekmece Lagoon (Brakish water) and Marmara Sea at Istanbul. Similar-sized animals and macroalgae were selected and acclimated to the laboratory conditions. ^{137}Cs uptake and loss in all samples was measured by using a multi-channel analyzer coupled to a well-type NaI (T1) crystal. An internal ^{137}Cs reference standard was used to correct for the different geometries. The overall propagated counting error was generally less than 5% at the 1 level.

The data in Table 1 show that the macroalgae and fish species did not accumulate the radionuclide to any great degree and concentration factors were correspondingly low, ranging from 1 to 6. However, brown shrimp and isopods were found to have a much higher affinity for cesium (Table 1). The results also indicated that salinity and temperature differences did not play an important role in the bioaccumulation of ^{137}Cs from water.

The elimination of ^{137}Cs from contaminated fish was examined under different temperature regimes. The bioelimination kinetics were clearly biphasic and were influenced by temperatures between 6°C and 16°C. Furthermore, longer biological half-lives were obtained when compared to the other loss experiment with polychaetes.

Cesium concentration factors in the same range as those for macroalgae and fish (*Proterorhinus marmoratus*) have been determined previously for other similar species (GUTKNECHT, 1965; HEWETT and JEFFERIES, 1976). On the other hand, the steady-state ^{137}Cs concentration factors in the isopod and brown shrimp were higher than those which have been reported for similar marine invertebrates.

From the data obtained with isopods and brown shrimp, we conclude that these organisms would be useful bioindicators for monitoring these Turkish coastal waters.

Table 1. Parameters for the ^{137}Cs biokinetic experiments.

Organisms	Temp. (°C)	Salinity* Regime	CF	K (d^{-1})	$Tb_{1/2}$ (day)	Function
			Uptake Experiment			
Enteromorpha linza	6	Lagoon	6	0.15395	4.5	$CF=6(1-e^{-0.15395})$
Nereis diversicolor	16	Lagoon	11	0.11773	5.9	$CF=11\ (1-e^{-0.11773})$
Idothea primastica	16	Lagoon	32	0.4058	1.7	$CF=32(1-e^{-0.4058})$
	6	Lagoon	33	0.2057	3.4	$CF=33(1-e^{-0.2057})$
	16	Sea	22	0.1303	5.3	$CF=22(1-e^{-0.1303})$
Crangon crangon	16	Lagoon	30	0.22381	3.1	$CF=30(1-e^{-0.22381})$
Proterorhinus marmoratus	16	Lagoon	2	0.13696	5.1	$CF=2(1-e^{-0.13696})$
	6	Lagoon	1	0.10126	6.8	$CF=1(1-e^{-0.10126})$
	16	Sea	3	0.17086	4.1	$CF=3(1-e^{-0.17086})$
			Loss Experiment			
Nereis diversicolor	16	Lagoon		0.1267	5.5	Log y=1.960-0.055 X
Syngnathus abaster	16	Lagoon				
		Slow comp.		0.0065	107	Log y=1.865-0.003 X
		Fast comp.		0.4149	1.7	Log y=1.428-0.179 X
	6	Lagoon				
		Slow comp.		0.0044	157	Log y=1.932-0.002 X
		Fast comp.		0.2887	2.4	Log y=0.962-0.123 X

* Salinity was 21.5°‰ in sea water and 6‰ in lagoon water.

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Suivi radioécologique du Littoral Méditerranéen Français - Les sédiments du Prodelta Rhodanien -

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La dispersion en mer Méditerranée occidentale des radioéléments véhiculés par le Rhône, et plus particulièrement leur devenir au sein des sédiments ont été étudiés lors de deux campagnes de prélèvements, l'une en Novembre 1990 et l'autre en Mars 1991 (Fig.1a). Ces campagnes s'inscrivent notamment dans le Programme National d'Océanographie Côtière (PNOC) dont l'un des objectifs est d'établir le bilan sédimentaire de cette région. Présents dans les eaux du Rhône sous forme dissoute mais également associés à la matière particulaire, les radioéléments artificiels rejetés par les installations nucléaires situées sur le cours du Rhône, constituent autant d'outils pour l'étude des processus dynamiques contrôlant le devenir des polluants anthropogènes dans l'environnement marin (CALMET *et al.*, 1992).

Compte tenu des niveaux de radioactivité et de l'équipement de mesure en spectrométrie gamma directe, 300cm³ de matière sont nécessaires à la mesure. Deux types d'engin de prélèvement ont été utilisés dans le cadre de ces campagnes, une benne Fluchat et un carottier à piston Kullenberg. La benne Fluchat présente une grande section (725cm²) permettant d'obtenir une quantité de matière suffisante pour réaliser un découpage centimétrique de la carotte, cependant sa pénétration ne dépasse pas 30cm environ. Cet engin permet donc d'avoir des profils verticaux assez précis des radioéléments au sein de la couche sédimentaire mais pour une épaisseur restreinte. Le carottier Kullenberg a une section plus faible (environ 50cm²) contraignant à un découpage tous les 10cm de la carotte afin d'obtenir une quantité de matière suffisante. Les profils verticaux sont moins précis mais concernent une épaisseur de sédiment plus importante, qui atteint 4,3m dans notre cas. Cet engin a donc été utilisé près de l'embouchure du Rhône où les apports sédimentaires sont les plus importants (fig. 1c).

L'ensemble des échantillons (environ 800) est en cours d'analyse par spectrométrie gamma. En fonction de ces résultats les isotopes du plutonium seront quantifiés sur une sélection d'échantillons. L'ensemble des résultats devrait permettre d'établir un bilan de la radioactivité artificielle déposée par les apports rhodaniens sur le plateau continental du Golfe du Lion. En outre, tenant compte des phénomènes de diffusion des radioéléments dans la colonne sédimentaire il sera tenté d'établir le volume de sédiment déposé sur le plateau depuis le début du développement du complexe nucléaire de la vallée du Rhône ainsi que de déterminer les charges particulaires véhiculées annuellement par ce fleuve. Des estimations ont été réalisées avec des données acquises jusqu'en 1980 (FERNANDEZ *et al.*, 1991), les résultats des mesures de ces nouveaux échantillons permettront d'affiner ces estimations.

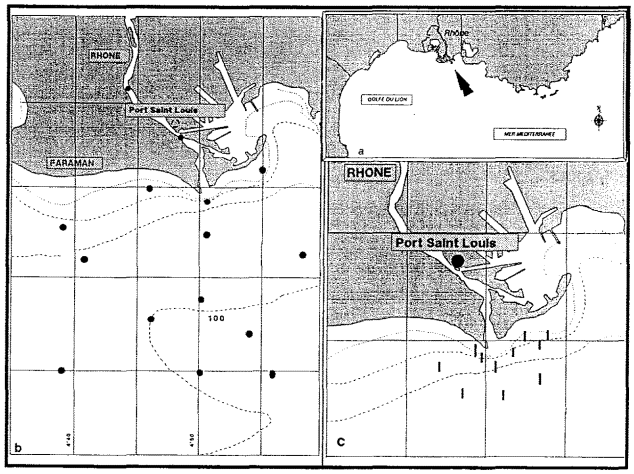

Figure 1: Localisation des prélèvements de sédiment réalisés dans le Golfe du Lion par benne Fluchat (b) et par carottier Kullenberg (c).

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Assessment of short-term radioactive contamination of river water resulting from the Chernobyl Accident

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A model is being developed at the Environmental Radioactivity Laboratory for the assessment of short-term consequences of direct contamination of rivers through deposition of radioactive material on the surface of the water. Using measurement data, the contribution of the Danube River as a source of contamination for the North-Western Black Sea in the first 2 weeks following the Chernobyl accident will be evaluated.

The model attempts to describe the time evolution of specific activity in river water, by taking into account contamination resulting from fall-out deposited on the river surface. It is a one-dimensional dispersion model which includes a correction for vertical diffusion (HALASZ, 1992). It is based on the following assumptions:

-The deposition rate is time-dependent and uniform along a given length of the river. Measured deposition data corresponding to the period of interest, are fitted to give a smooth deposition function, required as input.

-Water velocity, river depth, diffusion coefficients and sampling depth (depth up to which the inlet of the sampling recipient extends) are considered constant and required as input data.

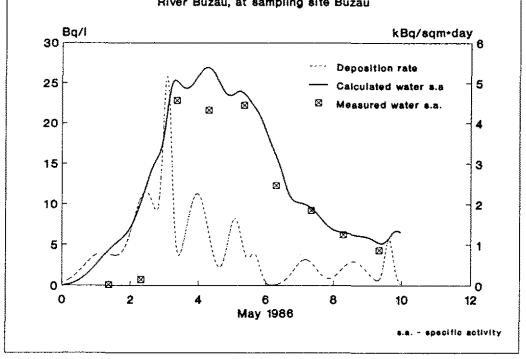
-A mixture of up to 15 radionuclides is considered. For most of the daily samples only gross beta activities are available. Using the relative concentrations of radionuclides in deposition samples (resulting from gamma spectrometrical analyses), required as input data, calculations are made for the radionuclidic composition on time subintervals 80 that the corresponding gross beta activity approximates the measured values.

The model has been tested using sets of data obtined through measurement of fall-out and river water samples performed up to May 10, 1986, following the Chernobyl accident, as illustrated in Fig. 1 for the case of River Buzau.

Fall-out and river water samples have been collected with a frequency depending on the type of the sample, but at least once a day, at the stations of the National Environmental Radioactivity Surveillance Network. Immediate gross beta measurements have been performed on all the samples. For the fallout samples and for some of the water samples gamma emmiter concentrations have been determined also.

At the present stage of development, the model, applied to the existing data sets, gives a reasonable agreement with the observed delay between the peak values in deposition rate and specific activity in water. In most cases the calculated amplitude of water specific activity approximates well the measured values, but the corresponding decrease is slower than the observed one.

Fig. 1. Measured and calculated values of specific activities in water of River Buzau, at sampling site Buzau



The main processes governing the shape of the peak in water specific activity are radionuclide accumulation vs. decay and longitudinal transport.

The effect of the longitudinal diffusion is small for the given ranges of parameters. The influence of vertical diffussion is important for the range used for the vertical diffusion coefficient.

There are cases in which the assumption that deposition is uniform over a large surface is not appropriate.

The model is to be developed by taking into consideration suspended and bed sediments as well as input coming from the drainage area. A finer resolution deposition map will be produced and hydrological characterization of each case will be completed in order to improve the input data. Such data are presently prepared for a case study of the Danube River, much more complex due to the contribution of tributaries, which will permit an evaluation of the input of radioactivity into the Black Sea, resulting from the direct contamination of the river.

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Inventories and vertical flux of transuranium nuclides in the Northwestern Mediterranean

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One of the principal aims of the oceanic flux studies currently underway is to assess spatial and temporal variability of the biogeochemical cycles of important elements. Globally, data on the flux of transuranics are sparse, and such information is essential for quantifying the removal rates of these anthropogenic radionuclides in the water column. In this context, we undertook a time-series sediment trap experiment to measure the vertical flux of $^{239+240}$Pu and ^{241}Am at an offshore station in the Gulf of Lions.

METHODS AND MATERIALS

During the EROS 2000 "CYBELE" cruise, automated time-series sediment traps (0.125 m^2 opening) were moored at 200, 500, 1000 and 2000 m in a 2475 m deep water column (42°N 06°E) off the coast of Toulon, France. Each of the six collection cups sampled a 13-day period between 14 April and 1 July 1990. Preservation methodology, sample treatment and preparation, and radionuclide analytical techniques are reported elsewhere (FOWLER *et al.*, 1990a; PEINERT *et al.*, in press). Water column sampling and radioanalyses followed the methodologies of FUKAI *et al.*, (1983) and BALLESTRA *et al.* (1984).

RESULTS AND DISCUSSION

Transuranic concentrations in sinking particles and corresponding radionuclide fluxes are given in Table 1. At 200 m, $^{239+240}$Pu concentrations in particles increased by a factor of 4.4 (1.92 - 8.45 Bq kg^{-1}) during the course of the experiment. Corresponding ^{241}Am levels were more variable (x10) but did not follow the same temporal trend. During sample series II and III, no clear trend in radionuclide concentration with depth was evident except for ^{241}Am immediately following the major sedimentation pulse of phytoplankton aggregates which swept the water column between 27 April and 10 May (PEINERT *et al.*, in press). The maximum fluxes of $^{239+240}$Pu and ^{241}Am coincided with the period of maximum sedimentation indicating that mass flux was the main factor controlling transuranic flux. These fluxes corresponded closely to those measured off Corsica during spring 1986 (FOWLER *et al.*, 1990b) but were an order of magnitude lower than $^{239+240}$PU and ^{241}Am fluxes reported for fall 1983 in the high sedimentation regime of the Lacaze-Duthiers Canyon in the Gulf of Lions (FOWLER *et al.*, 1990a). Clearly, variations in transuranic flux depend to a large extent on the degree of sedimentation.

The average $^{239+240}$Pu and ^{241}Am flux through 200 m during the 2.5 month period was 0.688 and 0.273 mBq $m^{-2}d^{-1}$, respectively. Transuranic concentration profiles in sea water measured at this site during early May resulted in corresponding radionuclide inventories above 200 m of 5.91 and 0.526 Bq m^{-2}. If a steady state situation is assumed, such fluxes would lead to a residence time for $^{239+240}$Pu and ^{241}Am in the upper mixed layers of approximately 24 and 5.3 y, respectively. These residence times are considerably longer than those reported for a short-term (17 d) experiment in the Lacaze-Duthiers Canyon (FOWLER *et al.*, 1990a), and are probably more representative of average transuranic flux in the northwestern basin as a whole.

High resolution $^{239+240}$Pu profiles taken at this station and a nearby site (43°25'N 07°53'E) during 1989-90 have allowed comparing present day water column $^{239+240}$Pu inventories with those determined from similar measurements made in 1981-82 in the same region (FUKAI *et al.*, 1983; BALLESTRA *et al.*, 1984). The difference in inventories for the 8-year period results in a mean $^{239+240}$Pu loss from the water column of roughly 0.5 Bq $m^{-2}y^{-1}$. Our measured mean $^{239+240}$Pu flux through 2000 m (Table 1) of 0.24 Bq $m^{-2}y^{-1}$ indicates that a significant fraction of the removal is due to vertical transport by sinking particles.

TABLE 1. Concentrations and vertical fluxes of transuranics in the Gulf of Lions

Sample Series	Date (1990)	*Depth (m)	Mass Flux mg $m^{-2}d^{-1}$	$^{239+240}$Pu (Bq Kg^{-1})	$^{239+240}$Pu mBq $m^{-2}d^{-1}$	^{241}Am (Bq Kg^{-1})	^{241}Am mBq $m^{-2}d^{-1}$
I	14-27/04	200	127.6	1.92±0.25	0.245	0.46±0.22	0.059
II	27/04-	200	308.9	3.83±0.29	1.183	3.29±0.46	1.016
II	10/05	500	48.6	2.82±0.40	0.137	1.48±0.59	0.072
II		1000	242.3	4.73±0.37	1.146	2.50±0.49	0.606
II		2000	240.8	3.36±0.28	0.809	3.33±0.46	0.802
III	10-23/05	200	181.8	5.28±0.63	0.960	0.32±0.17	0.058
III		1000	120.9	3.33±0.44	0.402	1.85±0.30	0.224
III		2000	174.4	3.02±0.34	0.527	2.40±0.31	0.418
IV	23/05-05/06	200	71.8	5.91±0.81	0.424	2.14±0.85	0.154
V	05-18/06	200	61.4	7.60±0.92	0.467	2.52±1.04	0.155
VI	18/06-01/07	200	100.5	8.45±0.86	0.849	1.92±0.80	0.193

* Missing depths = insufficient sample for transuranic analyses.

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R

Distribution of Transuranics along the Palomares Submarine Canyon

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Transuranics and other long-lived radionuclides are useful tools to evaluate transport processes along the rivers and through the sediments. They also serve as tracers to determine the behaviour of other pollutants of industrial origin in the marine ecosystem.(1)

The radioecology studies in Palomares region have focused on two fields : a) Study of the behaviour and preferential migration of the transuranics, plutonium and americium, in the Almanzora dry river bed (gulch); b) Study of land-to-sea transfer from the river to the neighbouring continental shelf (the main recipient of the rivers terrigenous contribution), and subsequent transport of these radionuclides through submarine canyons.

The influence of the turbidity currents, formed along the slope, on the transport of radionuclides trough submarine canyons is well-known. These currents play an important role in transferring radionuclides from continental shelves to offshore areas. These processes will be studied in Palomares canyon and compared with another Mediterranean canyons (i.e. Taranto Canyon), in the frame work of cooperation among participants in CEC-sponsored Radiation Protection Programme.

The Palomares continental shelf shows a group of secondary canyons tributaries of the main Canyon. The activity in the canyon could transport the radionuclides fixed in the shelf sediments to deeper areas.

The studies of this area started in 1985 (2, 3, 4) and will be completed with the results obtained from a sampling cruise in 1991 on board the vessel Bannock. (5)

Sampling

a) Sediments (1991)

Thirteen stations, located in the sea close to the Almanzora river mouth were selected for study in order to assess whether the status of this sensitive environment had changed since the previous study (1) and to determine whether a significant portion of the americium present in this environment was in the form of the so-called "hot particles"(6). Additional objectives were to evaluate recent terrigenous contributions and to investigate the role of submarine canyons in the transport of transuranics. Sampling was carried out along the main Almanzora river canyon and to the south of its mouth. Marine sediment samples were collected with a box-corer designed to slice sections of 1 cm thickness. The analyses of Pu, Am were carried out at CIEMAT following standard procedures.

b) Sea water and suspended particulate matter (1991)

The Palomares area is located in a semi-desert region and receives frequent winds. It is well established that such winds can produce the resuspension of deposited transuranics and may, in fact, give rise to a measurable land to sea transfer via airbone translocation. This fact could produce a temporary increase in transuranic concentrations in coastal waters close to Palomares and, possibly, further afield. Therefore, the water-sampling programme is expected to provide the first comprehensive data on transuranics concentrations in suspended particulate matter and filtered sea water. Surface and near-bottom water samples were collected from two stations, one close to Palomares in the predominant wind direction and the other near the end of the submarine canyon. The 200 l samples were obtained with Gerhard-Ewing bottles and transferred to 500 l containers prior to preliminary chemical concentration of the transuranics. UCD and UAB (5) carried out separation of the suspended particulate matter from sea water and the radionuclide preconcentration step. The radiochemical analysis were performed by CIEMAT. This work will be complemented by chemical speciation and colloidal association studies undertaken by UCD in the Vera Gulf and western Mediterranean.

Preliminary results

Transuranic concentration profiles from four different stations have been completed. Some preliminary results are shown in the table below.

Station	Depth(m)	Inventory(Bq/m^2)		$^{238}Pu/^{239+240}Pu$
		$^{239+240}Pu$	^{238}Pu	
13	49	63.47	1.31	0.02
17	71	54.39	1.10	0.02
16	599	4.42	0.16	0.04
07	1025	2.11	0.34	0.15

These results will be compared with those previously obtained in the area in 1985.

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R

Fission track measurements of uranium concentration and distribution in the Mussel *Mytilus galloprovincialis* and some macrophytes from the Romanian Sea Coast, 1987-1990

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Abstract

The bivalve mollusc *Mytilus galloprovincialis* and the macrophytes *Enteromorpha linza, Cystoseira barbata* and *Ceramium rubrum* were analyzed for uranium by the fission track micro-mapping technique. Pending on the site sampled, a variation in uranium concentration was found in *M. galloprovincialis* which decreased from the north to south along the coast of Romania. In the macrophytes, uranium distribution was generally uniform except for *C. rubrum* in which U is found as inclusions.

Introduction

In a previous research (DANIS *et al.*, 1979), the uranium distribution and content in Black Sea rocks, sediments and water were determined by the fission track method. These results, along with those of other investigators (Georgescu *et al.*, 1990) on the uranium content in different biota, permit us to discern the uranium distribution in the mussel *Mytilus galloprovincialis*, the macrophyte *Enteromorpha linza (Ent.l.), Cystoseria barbata (Cyst.b.)* and *Ceramium rubrum (Cer.r.)* from the Black Sea during 1987-1990.

Materials and Methods

Mussels of 4-5 cm length were sampled from different depths along the Black Sea Romanian shoreline during 1987-1990. The soft tissue and the byssus were dissected and dried at 105°C. Measurements of U distribution and content were performed using the uranium micro-mapping technique. Uranium micro-mappings were obtained both for natural and powedered dry samples in the following way: the samples, placed in intimate contact with the muscovite track detector sheets, were irradiated with thermal neutrons at fluxes of $\approx 10^{14}$n cm^{-2} in the VVR-S reactor in Bucharest. During neutron irradiation, the fission fragments from the neutron induced fission of the uranium nuclei were corded by trails in the muscovite detectors. These tracts were observed by optical microscopy following chemical etching by HF≥38% for 4 hours at room temperature. Thus, in muscovite detectors the fission track replica of the uranium distributions were obtained (Fig.1). The SL-1 IAEA Certified Reference Material was used in the determinations of U content in the samples. For each sample analyzed, three separate analyses were performed.

Results and Discussion

1. In all samples of mussel, uranium was more concentrated in the soft tissues than in the byssus.

2. A decrease of U concentrations was observed in mussels going from the north to the south along the Romanian Black Sea shore. During 1987, this variation ranged between 0.21 ± 0.03 ppm to 0.11 ± 0.03 ppm in the soft tissue. In the byssus, a mean value of 0.07 ± 0.01 ppm was observed.

3. During 1989 in the southern Danube Delta at Portitza, elevated uranium levels (0.89 ± 0.13 ppm) were observed in the soft tissue of mussels which is assumed to be due to contamination.

4. In most of the macrophytes analyzed, uranium was uniformly distributed, except in the case of *Ceramium rubrum* which contained numerous uranium inclusions. These inclusions are represented by track clusters in the micromass (Fig.1) and range between 10.5 ± 1.6 ppm and 134 ± 20 ppm for *C. rubrum*. In *E. linza*, the uranium concentration varied between 0.42 ± 0.06 ppm at Eforie South (1987) and 0.13 ± 0.02 ppm at Mangalia (1990). For *C. barbata*, the uranium ranged from 0.10 ± 0.01 ppm to 0.18 ± 0.03 ppm.

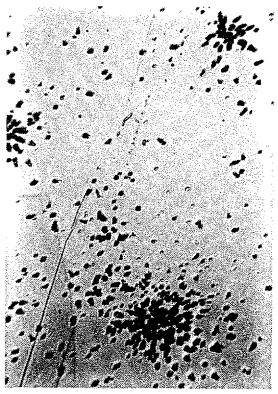

Fig. 1. Detail of U fission track micro-mapping in a Ceramium rubrum sample (x 900 magnification).

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Man-made and natural radionuclides measured in the Danube River during 1991

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Abstract

Water and bed sediments sampled on principal cross-sections of the Danube River were analysed by gamma spectrometry. Cs-137 was present in low activity, while Th-232, U-238 and K-40 levels were typical of distributions normally encountered.

Introduction

Previous experimental research on the identification of man-made and natural radionuclides in the Danube River was carried out at the Polytechnical Institute of Bucharest with the objectives of determining, a) radioactive pollution at a specific time, b) estimation of the dilution capacity of the Danube River and, c) the elaboration of a mathematical model for transport of radionuclides to the Black Sea (GEORGESCU *et al.*, 1980, 1981). The aim of the present work was to identify the presence of Cs-137 ($T_{1/2}$=30.2 y) as well as U-238 and Th-232 after the Chernobyl accident.

Materials and Methods

Water (50 l) and sediments were sampled during June 1991 along major cross-sections of the Danube River and analysed for radionuclides using established procedures (GEORGESCU *et al.*, 1981). The gamma-emitting radionuclides were identified using a HPGe crystal coupled to a multi-channel analyser. Both samples and reference materials (IAEA-306) were counted in the same geometry for 18-24 hours.

Results and Discussion

Cs-137, Th-232, U-238, K-40 were identified in bed sediments (Table 1) and in unfiltered surface water (Table 2). Cs-134 ($T_{1/2}$=2.07 y) was present in the bed sediments of all the cross sections of the Danube River, but only in low activity, i.e. <0.2-<0.6 Bq/Kg dry. It should be noted that the sediments collected on the Romanian shore (left bank of River) are composed of silty clay, which may explain the somewhat generally higher accumulation of Cs-137 and other radionuclides.

Table 1. Activity in Bq/Kg dry sediment.

Sampling Site/ Date		^{137}Cs	^{238}U	^{232}Th	^{40}K
Upstream from Bechet Km 705 17.06.91	Left bank	8.2 ± 0.7	37 ± 2	22 ± 2	326 ± 16
	Centre	3.6 ± 0.3	20 ± 2	10 ± 1	261 ± 13
	Right bank	2.2 ± 0.2	20 ± 2	12 ± 1	304 ± 15
Bechet 18.06.91	Left bank	5.6 ± 0.4	28 ± 2	20 ± 2	339 ± 17
	Centre	3.8 ± 0.3	25 ± 2	8.7±1.3	260 ± 12
	Right bank	2.9 ± 0.3	18 ± 2	8.4±1.3	255 ± 10

The sediments, near the right bank have a higher granulometric composition and, therefore, do not readily accomodate the radionuclides in the crystalline lattice.

Table 2. Activity (Bq/m³) of unfiltered Danube river surface water in 1991.

Sampling Site/ Date		^{137}Cs	^{238}U	^{232}Th	^{40}K
Entrance of Danube into Romania, 9.06.91	Left bank	<96	<27	<13	<95
	Centre	<48	<32	<12	<36
	Right bank	<46	<29	<14	<45
Upstream from Bechet Km 705 17.06.91	Left bank	<101	<27	<17	<99
	Centre	<55	<32	<14	<100
	Right bank	<91	<29	<15	<103
Bechet 18.06.91	Left bank	<43	<31	<9	<56
	Centre	<100	<36	<5	<115
	Right bank	<92	<29	<14	<101
Turnu-Magurele 19.06.91	Left bank	<81	<8	<10	<90
	Centre	<41	<31	<16	<105
	Right bank	<95	<31	<15	<48

Conclusions

At the time when these Danube samples were collected (June 1991), the measured radioactivity in water and bed sediments ranged within the limits of the natural fluctuation. This was also the case at the Bechet site in front of the Kozlodui Nuclear Power Plant which is located on the right bank of the Danube River.

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Uranium as a pollutant from fertilizer industries located on the Black Sea shore and upstream from the Danube Delta

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Introduction

It is known that hazards can arise from the industrial plants using raw phosphorus materials to prepare fertilizers for agriculture purposes, due to release of dust and polluted waters into the environment. This waste contains not only toxic stable micro-elements such as As, Cd, Cr, Hg, Zn, etc., but also radioactive elements like U and Th in different concentrations. SALAGEAN *et al.* (1988) investigated U, Th and characteristic micro-elements in biota from the Romanian Black Sea shore, while others (FRONTASIEVA *et al.*, 1991) pointed out that phosphorus fertilizers contain some elements whose accumulation in vitally important media such as water, soil and food are undesirable from the medical-hygienic point of view. In the present work, we investigated only the U content of phosphorus raw materials and finite fertilizers obtained by nitric and sulphuric acid procedures in industrial plants located along the Romanian Black Sea coast and upstream from the Danube River Delta. Owing to contaminated radioactive water entering the sea either from direct discharge of the water or via migration through soil, we can gain information on the uranium concentration in the biota living in these waters.

Materials and Methods

Raw phosphorites imported from Algeria, Morocco, Tunisia, Jordan, Israel, U.S.A. (Florida) and apathite from the Kola Peninsula (Russia), as well as the finite fertilizers derived by nitric or sulphuric acid procedures were obtained as samples. About 100 g dry of each powdered sample was placed in a plastic bag and measured for uranium activity by gamma-spectrometry. All the samples were counted in the same geometry using a Phoswich (USA) detector of 127 mm dia. [3 mm NaI(T1)+50 mm CsI(T1)] coupled to a multichannel analyzer and personal computer. This system could detect either the 63 keV and 93 keV gammas from the Th-234 daughter of U-238 or the 186 keV from U-235.

Results and Discussion

The experimental data are shown in Tables 1 and 2. A significant quantity of uranium is noted in the final products. By correlating the chemical and radiological limits with the U content in the finite fertilizer products, it has generally been recommended to avoid the maximum possible uranium from all fertilizers. However, in our fertilizers U is not considered dangerous for several reasons. If we consider that 2-3 kg (case 1) or at maximum 200-300 kg (case 2) of finite fertilizer NPK2 nitric product (Table 2) with the highest U content (i.e. 28.85 mg/kg corresponding to an activity of 721.25 Bq/kg) is sprayed on 10,000 m², it means a variation of U activity ranging between 0.1442 to 0.21637 Bq/m² (case 1) or 14.42 to 21.637 Bq/m² (case 2). Upon the recommendations of ICRP-30 (1979), the Annual Limit on Intake (ALI) of natural U in critical organs (lungs, kidneys), is 1.5x10³ Bq which corresponds to 60 mg natural U. However, an important quantity of U is retained by chemically complexed compounds such as humic acids in the soil and sediments of the Danube or Black Sea. Previous investigations by SALAGEAN *et al.* (1988) on U content in biota from the Black Sea have found 0.6 ppm in *Enteromorpha linza*, 2.8 ppm in *Ceramium rubrum* and <6 ppm (soft tissue) and <4 ppm (byssus) in *Mytilus galloprovincialis* from the Danube Delta near Sulina.

Table 1. Uranium content in raw samples

Sample	mg/Kg	Bk/kg*
Phosphorite Morocco	131.07	3276.75
Phosphorite Tunisia	40.42	1010.50
Phosphorite Jordan	73.21	1830.25
Phosphorite calcinated Morocco	148.58	3714.50
Phosphorite calcinated Algeria	56.37	1409.25
Phosphorite calcinated Israel	272.7	6817.50
Phosphorite calcinated U.S.A.	15.99	399.75
Apathite Kola (Russia)	141.46	3536.50

Table 2. Uranium content in fertilizers (finite products)

Fertilizer	mg/kg	Bk/kg*
NPK_2 nitric product	13.84	346.00
NPK_1 sulphuric product	15.27	381.75
NPK_2 nitric product	28.85	721.25
NPK_1 sulphuric product	27.30	682.50
NPK_2 nitric product	10.34	258.50
NPK_2 nitric product	2.82	70.50

* 1 mg U generates 25 Bq for natural uranium (88 - EHD - 139 Bioassay Guideline 4. Guidelines for U Bioassay. Health and Welfare - Canada)

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R

Effect of speciation on cobalt bioavailability to marine organisms

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Much of our knowledge of the behaviour of Co in the marine biosphere comes as a result of studies with ^{57}Co, ^{58}Co and ^{60}Co, all of which are present in fallout and in discharges from nuclear facilities. These radionuclides have been detected in a variety of marine species, with reported concentration factors (CF) for phytoplankton, crustaceans, and fish of about 1500, 700, and 250, respectively (GOMEZ *et al.*, 1991), in agreement with values reported for stable Co by PENTREATH (1977). In contrast, CFs obtained from laboratory radiotracer studies tend to lie between 10 and 50 (HARRISON, 1986). Upon consideration of the work by LOWMAN & TING (1973) on the preferential uptake of Co-cobalamine over cobalt in marine organisms, we questioned whether the speciation of the metal could be responsible for the observed differences in CFs. Instances abound where the physicochemical speciation of substances are known to affect their bioavailability, *e.g.* in food *vs* water (Co, Ru, Cs, Sr; SUZUKI *et al.*, 1979) and organic *vs* inorganic (Co; UEDA *et al.*, 1981) experiments.

In seawater, the metal is present primarily as the Co^{++} ion, and its chloro-, sulfato-, and carbonato-complexes. Of the soluble cobalt fraction, cationic, anionic, and neutral species have been detected, and there have been several reports of the formation of complexes with various organic ligands in natural waters and under laboratory conditions (LOWMAN & TING, 1973). Concentrations of the metal in seawater vary up to *ca* 0. 1 $\mu g\ l^{-1}$, decreasing away from continental margins to 7 ng l^{-1} in oceanic surface waters (KNAUER *et al.*, 1982, COUGHTREY& THORNE, 1983). Co-cobalamine has also been detected in seawater, but at levels of the order of 0.1 ng l^{-1} (LOWMAN & TING, 1973) . Thus, cobalt associated with cobalamine represents about a one thousandth part of the total soluble metal in open waters. It has not been shown whether the Co-cobalamine in seawater is utilised by biota. Here we describe the results of laboratory radiotracer studies which have examined the relative bioavailability of ionic cobalt and co-cobalamine to different marine organisms.

Experimental Results

We completed studies on the uptake and retention of both cobalt species in a simple marine food chain comprising phytoplankton (*Dunaliella tertiolecta* and *Chaetoceros pseudocurvisetum*), copepods (mainly *Centropages* sp.), and fish (*Serranus scriba*). Retention of both forms of Co from the diet was also studied for the latter two organisms.

Phytoplankton accumulated more than 60 times as much Co-cobalamine as of $CoCl_2$ from the water, and retained the metal for a significantly longer period (a retention half-time of 4.4 *vs* 0.6 d) . Accumulation of $CoCl_2$ after ingestion of radiolabelled phytoplankton by copepods was not measurable, whereas retention of Co-cobalamine reached 42% of the quantities ingested. Fish accumulated Co-cobalamine 21 times more rapidly from seawater than they did $CoCl_2$. They retained ingested Co-cobalamine (100%) 20 times more efficiently than ingested $CoCl_2$ (5%), with one third of the ingested Co-cobalamine being retained with a half-time of 8 d and the remaining two thirds with a half-time of 53 d, a value which was not significantly different from the retention half-time of $CoCl_2$ (47 d).

Discussion and Conclusions

The application of the measured parameters to a simple three-compartment biokinetic model (NOLAN *et al.*, 1990) showed that food is the main source of the metal in marine fish and that preferential accumulation in the food web of the Co-cobalamine complex over inorganic cobalt species could explain the cobalt concentrations measured in marine organisms. When the model parameters are modified, so that inorganic cobalt parameters are used for uptake from water, and cobalamine parameters are used for uptake from food, then a CF of 200 (80% of which is accounted for by the diet) is predicted. This value is greater than anything reported from laboratory investigations, but is similar to environmentally determined CF values, which were based on stable cobalt analysis in fish (PENTREATH, 1977).

In conclusion, we consider that there is preferential uptake and retention of cobalamine-associated cobalt by marine biota. Because of the persistence of the vitamin in the water column, and in spite of the relatively tiny fraction of the total soluble cobalt which is associated with it, this compound represents a major source of the metal in marine organisms, the importance of which is out of all proportion to its relative concentration in the water.

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R

Trace element analysis and radionuclide measurements in a Mediterranean Tuna Fish sample

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Abstract

The results of instrumental neutron activation analysis of 16 elements and the determination of artificial and natural radionuclide levels in the Mediterranean tuna fish homogenate (IAEA-350 and IAEA-352, reference materials) are reported.

Introduction

Tuna fish (about 200 kg) were collected in the Western Mediterranean Sea in April 1988 in order to establish a new biological reference material. The flesh was separated from approximately half the fish and prepared as an intercomparison sample of trace metals and organochlorine compounds. A second sample, consisting of 80% fish flesh and 20% bones, was prepared for the radionuclide analyses. This paper represents our contribution to the intercomparison exercises for these two reference materials organized by the IAEA Marine Environment Laboratory in Monaco.

Experimental

For neutron activation analysis, the samples and standards (MA-A-2/TM and Soil-7) were irradiated in a VVR-S reactor at 10^{11} - $2.10^{12} n.cm^{-2}.s^{-1}$ flux. The induced and natural gamma spectra were measured using a high resolution HPGe detector coupled to a multi-channel analyzer.

Results and Discussion

Our results for concentrations of Cr, Fe, Rb, Sb, Se, Zn and their certified values are presented in Table 1. Except for Se, our values are in very good agreement with the certified values. Concentration values for Al, As, Au, Br, Cl, Co, Cs, K, Mg and Na determined in our laboratory, but non-certified, are presented in Table 2.

Table 1. Certified values of elemental concentrations in tuna fish flesh (IAEA-350, reference material)

Element	Concentration	Confidence interval	Our values
Cr (ppm)	0.75	0.55 - 1.01	0.82 ± 0.11
Fe (ppm)	72.1	66.7 - 77.3	74.6 ± 3.7
Rb (ppm)	2.50	2.41 - 3.40	2.9 ± 0.3
Sb (ppb)	20	3 - 80	41 ± 3
Se (ppm)	5.51	4.40 - 5.95	6.9 ± 0.2
Zn (ppm)	17.4	16.6 - 18.5	16.9 ± 0.7

The ^{40}K and ^{137}Cs activities determined by direct gamma spectrometry are presented in Table 3. Concerning ^{134}Cs activity, from the eleven results submitted, eight included "less than" and one N.D. An upper limit of 2.4 Bg/kg for ^{134}Cs has been estimated in our laboratory.

Table 2. Non-certified values of elemental concentrations in tuna fish flesh (IAEA-350, reference material) determined in our laboratory

Element	Concentration
Al (ppm)	35 ± 3
As (ppm)	5.6 ± 0.3
Au (ppb)	1.0 ± 0.3
Br (ppm)	16.3 ± 0.6
Cl (ppm)	2179 ± 50
Co (ppb)	34 ± 4
Cs (ppm)	0.21 ± 0.03
K (%)	1.541 ± 0.060
Mg (ppm)	2664 ± 247
Na (ppm)	1506 ± 47

Table 3. Certified values of radionuclide activity in tuna fish flesh (IAEA-352, reference material) Reference date: 1 January 1989

Radionuclide	Activity (Bq/kg^{-1})	Confidence interval	Range of accepted lab means	Our values
^{40}K	391	379 - 405	300 - 470	370 ± 8
^{137}Cs	2.7	2.5 - 2.8	1.9 - 3.5	2.8 ± 0.3

Our results in Table 3 are also in good agreement with the certified activity values for ^{40}K and ^{137}CS

A comparison of the behaviour of ^{51}Cr in the trivalent and hexavalent states in three mollusc species

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The presence of radioactive ^{51}Cr in the marine environment has been pointed out previously by several investigators. Chromium-51 is found in sea water in the trivalent and hexavalent states (FUKAI, 1967). In our previous papers (PAPADOPOULOU *et al.*, 1986, STAMOULI and PAPADOPOULOU, 1988, PAPADOPOULOU and STAMOULI, 1989, STAMOULI and PAPADOPOULOU, 1990) we studied the accumulation of ^{51}Cr in the trivalent and hexavalent forms in various mollusc species. Based on the results of these studies we thought that a comparison of the accumulation of the two different valence states of ^{51}Cr by these species would be of interest.

The mollusc species studied were *Venus verrucosa*, *Venerupis aureus* and *Mytilus galloprovincialis*. These edible species, which are common in Greek coastal waters and have a commercial value, were sampled from a farm in Salamis Island, Saronikos Gulf (Greece).

The uptake experiments were performed in different aquaria for each species (T=20°C, S=38‰) using the gamma ray emitting radioisotope ^{51}Cr (H.L. 27.8 d) in the trivalent state (as chromic chloride) or in the hexavalent state (as sodium chromate) at radioactivity concentration 40 µCi ^{51}Cr/20 l sea water. The uptake experiments lasted 20-27 days. After the end of the uptake experiments the distribution and concentration of the accumulated ^{51}Cr in the trivalent or hexavalent forms in the different parts of the bodies of the mollusc species were determined.

The accumulation of trivalent ^{51}Cr by the three species was found to follow a similar pattern: In the first days of the uptake experiments $^{51}Cr(III)$ was rapidly concentrated and reached a stable level within a few days (8-10 days). Medium concentration factors were determined (K=65 in *Venus verrucosa*, K=47 in *Venerupis aureus* and K=55 in *Mytilus galloprovincialis*). The accumulation of hexavalent ^{51}Cr followed also a similar pattern in the three mollusc species but different from that of the trivalent ^{51}Cr. After the more rapid uptake of $^{51}Cr(VI)$ during the first days of the experiments the rate of accumulation was found to decrease; but, over a period of 27 days equilibrium concentrations were not attained. The uptake of hexavalent ^{51}Cr by these species was low, the concentration factors after 27 days reaching the values K≈2 in *Venus verrucosa*, K=4.7 in *Venerupis aureus* and K=6.1 in *Mytilus galloprovincialis*.

Comparison of the distribution patterns of ^{51}Cr in the trivalent and hexavalent states in the tissues of the three mollusc species showed that the percentage of the whole body $^{51}Cr(VI)$ radioactivity determined in the soft parts was higher than that of $^{51}Cr(III)$. Among the soft parts of these species the percentage of $^{51}Cr(VI)$ detected in viscera showed lower values than that of $^{51}Cr(III)$, while the fractions of $^{51}Cr(VI)$ determined in muscle, mantle and gills were higher than those of $^{51}Cr(III)$.

Based on the above mentioned results it could be noted that the physiological behaviour of chromium in the studied mollusc species seems to be influenced by its valence state.

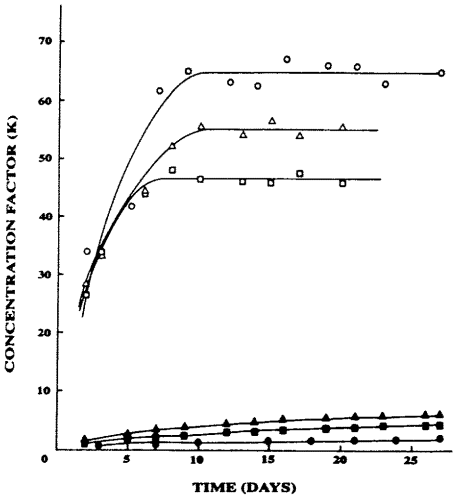

Fig. 1. Comparison of the accumulation of ^{51}Cr in trivalent and hexavalent states by three mollusc species.
1) *Venus verrucosa*: ○ $^{51}Cr(III)$, ● $^{51}Cr(VI)$,
2) *Venerupis aureus*: □ $^{51}Cr(III)$, ■ $^{51}Cr(VI)$,
3) *Mytilus galloprovincialis*: △ $^{51}Cr(III)$, ▲ $^{51}Cr(VI)$

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Etude de l'élimination du ^{134}Cs et ^{137}Cs provenant des retombées de Tchernobyl chez *Mytilus* Sp. prélevées à Nice

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Les retombées de l'explosion du réacteur 4 de la centrale de Tchernobyl le 26 Avril 1986, ont été significatives sur l'est du littoral méditerranéen français. Depuis 1983, des prélèvements de *Mytilus sp.* sont collectés mensuellement à différentes stations du littoral méditerranéen dans le cadre d'un réseau d'observation de l'ensemble des côtes françaises. Parmi ces stations, celle de Nice constituait jusqu'en Avril 1986 une station uniquement influencée par les retombées atmosphériques des tirs d'armes nucléaires réalisés dans le passé. Après Tchernobyl les échantillons révèlent l'apparition de toute une série de radioéléments et notamment des ^{134}Cs, ^{103}Ru, ^{106}Ru et un accroissement des teneurs en ^{137}Cs. CALMET *et al.*, (1988) ont étudié l'élimination du ^{103}Ru et du ^{106}Ru, éléments à période plus courte que le ^{134}Cs et le ^{137}Cs, et qui n'ont plus été détectés respectivement à partir de janvier et décembre 1987. Nous abordons ici l'étude de l'élimination du ^{134}Cs, élément qui a été détecté jusqu'en septembre 1988 et du ^{137}Cs, qui est trouvé à partir de novembre 1988 à des niveaux analogues à la période précédant l'accident de Tchernobyl.

Leur élimination a été étudiée à l'aide d'un modèle dérivé de BADIE *et al.*, (1985). Il décrit l'évolution de la concentration en radioéléments dans un organisme représenté par un système à deux compartiments échangeant entre eux et avec le milieu extérieur des radioéléments (figure 1). Certaines hypothèses simplificatrices permettent d'aboutir à une solution analytique, exprimant la cinétique d'élimination du radioélément par l'organisme en fonction du temps:

$$C(t) = C(t_0)\,[\,A_1\, e^{-(\lambda_1+\lambda_p)t} + A_2\, e^{-(\lambda_2+\lambda_p)t}\,]$$

$\lambda_i = \ln(2)/Tb_i$ avec Tb_i le temps mis par un organisme pour éliminer la moitié du polluant radioactif qu'il a incorporé (période biologique).

λ_p (décroissance physique) = $\ln(2)/Tp$ avec Tp période physique du radioélément,

A_i : contribution du compartiment i dans l'élimination d'un radioélément (%) avec ΣA_i = 100%,

$C(t_0)$: concentration initiale en radioéléments dans l'organisme.

Les paramètres du modèle sont ajustés par la méthode de Gauss-Marquardt qui minimise la Somme des Carrés des Ecarts (SCE) entre les valeurs observées et les valeurs calculées par le modèle.

Les paramètres de l'élimination des isotopes du césium sont regroupés dans le tableau 1. Les périodes biologiques sont du même ordre de grandeur que celles trouvées à Monaco par WHITEHEAD *et al.*, (1988). Les isotopes du césium (^{134}Cs, ^{137}Cs) présentent des périodes biologiques longues plus importantes, de l'ordre de 300-500 jours, par rapport à ceux du ruthénium (^{103}Ru, ^{106}Ru), environ 100 jours (CALMET *et al.*, 1988). Ceci est certainement imputable au fait que le césium est un analogue du potassium qui joue un rôle dans le métabolisme des organismes alors que le ruthénium n'a aucun rôle biologique connu. Les isotopes du césium entrent donc dans les structures des organismes notamment les muscles et leur dépuration est de ce fait plus longue.

Lieu	Tb_i (jours) A_i(%)	^{134}Cs	^{137}Cs
Nice	Tb_1 Tb_2	24,5 489,2	22,3 382
	A_1 A_2	94 6	93 7
Monaco(*)	Tb_1 Tb_2	14 300	14 300

Tableau 1 : Périodes biologiques (Tb_i) et contributions relatives (A_i) après ajustement d'un modèle à 2 compartiments pour l'élimination du ^{134}Cs et du ^{137}Cs dans les moules prélevées à Nice et (*) résultats obtenus par WHITEHEAD *et al.*, (1988) à Monaco.

Les contributions du compartiment I sont très élevées (>90%). En effet, VAN WEERS (1973) montre que pour une période d'accumulation courte, comme c'est le cas ici, la phase d'élimination est courte et se traduit par une augmentation de la contribution du compartiment à composante rapide A_1 par rapport à celle du compartiment à élimination lente A_2.

Les prélèvements de moules à Nice dans le cadre du réseau d'observation ont été réalisés pour le mois d'Avril, le 21 donc juste avant l'accident et pour le mois de Mai, le 22 soit 18 jours environ après les retombées maximales sur cette région. Une estimation des concentrations initiales $C(t_0)$ au 4 Mai 1986, date des retombées maximales sur cette région (BALLESTRA *et al.*, 1987 et FOWLER *et al.*, 1987), a donc été réalisée avec le modèle pré-cité et les valeurs suivantes ont été déterminées: 164 $Bq.kg^{-1}$ de cendres dans la chair des moules pour le ^{134}Cs et 392 pour le ^{137}Cs. Ces valeurs sont comparables à celles trouvées par WHITEHEAD *et al.*, (1988) et apparaissent conformes au rapport isotopique des ^{134}Cs et ^{137}Cs caractéristique des retombées de Tchernobyl (voisin de 0,5).

Remerciements :
Les mesures *in situ* dont nous disposons font partie des résultats d'un réseau d'observation de la radioactivité du littoral français mis en place depuis 1983 par le Service d'Etudes Appliquées de Protection Sanitaire du Centre d'Etudes de Fontenay-aux-Roses.

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R

Natural depuration rate of Chernobyl-derived ^{137}Cs in mussels (*Mytilus galloprovincialis*) from the Bosphorus

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During the days following the accident at the Chernobyl Nuclear Plant, increased levels of radioactivity were detected in fish and mussel samples from the Black Sea, Marmara Sea and the Bosphorus (TOPCUOGLU *et al.*, 1988). In this earlier study, ^{131}I, ^{103}Ru, ^{134}Cs and ^{137}Cs were determined and the results have been reported as total activity. Since then, the monitoring programme in our laboratory has especially focused on marine organisms from the Black Sea and Marmara Sea to follow contamination trends after the Chernobyl accident (GUVEN *et al.*, 1990; BULUT *et al.*, 1990).

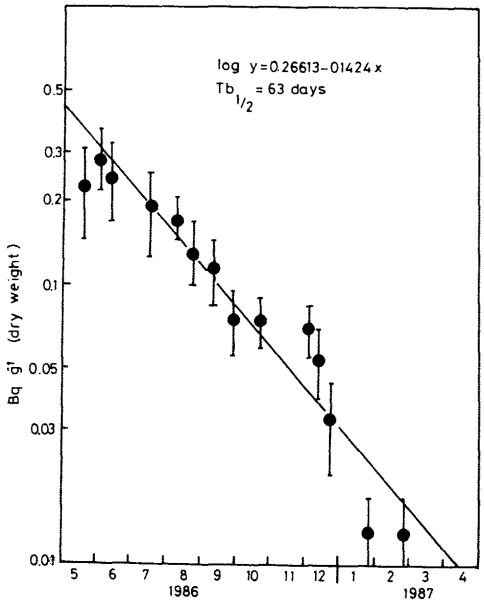
Several papers have been published concerning the biokinetics of ^{137}Cs in marine organisms under laboratory and field conditions. However, data on the biokinetics of ^{137}Cs in naturally-contaminated marine biota following the Chernobyl input are limited (WHITEHEAD *et al.*, 1988). We report here the results of our ^{137}Cs depuration rate measurements in mussels (*Mytilus galloprovincialis*) collected from the same Bosphorus station from May 1986 to February 1987.

Samples were collected at regular intervals and similar-sized mussels were dissected and soft parts were removed for analysis. The soft tissues were dried at 85°C, the dry weight was recorded and the samples were ground to powder and placed in a special cup. The cup was placed directly on a detector of high purity germanium with a resolution (FWHM) of 1.8 keV (at 1332.5 keV for ^{50}Co). All activities were corrected for decay to the date of the Chernobyl accident.

The decrease of ^{137}Cs activity in the mussel with time, or natural depuration rate, was estimated as the biological half-life which was observed under environmental conditions after Chernobyl. The depuration values have been fitted to a single component represented by the equation Log y = Log a+X Log b. From this equation, the depuration rate constant (k=log b*2.3) and biological half-life ($Tb_{1/2}$ = 0.693*k^{-1}) were calculated (Fig. 1).

If we could have obtained more measurements, especially during the first month following the accident, we would have observed an exponential decrease in radioactivity. The biological half-life of 63 days we found is not considerably greater than the 40 days obtained for ^{137}CS in mussels exposed to radioactivity in the Irish Sea (CLIFTON, 1983). Furthermore, a ^{137}Cs biological half-time of 75 days has been reported for a marine clam maintained under field conditions (HARRISON, 1973). On the other hand, WHITEHEAD *et al.* (1988) reported a biological half-life of 300 days in the slow component in mussels exposed to Chernobyl fallout in the northwestern Mediterranean. Clearly, ^{137}Cs depuration rates in Mediterranean mussels are variable and likely depend on several key parameters such as salinity, temperature, and growth, to mention a few.

Fig. 1. Depuration of Chernobyl-derived ^{137}Cs from mussels living in the natural environment.



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A study on the levels of natural gross beta radioactivity of some mollusc species and their sediments from Izmir and Aliaga Bays

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Marine ecosystems receive and accumulate natural and artificial radionuclides from many different sources and ways. Radionuclides when entering bays and estuaries precipitate and settle to the bottom where they are taken up by sediments and biota. Thus radioactive pollution in bay and estuarine waters is potentially hazardous to aquatic organisms, since the radioactive elements are absorbed by bottom dwelling and burrowing organisms not only from water, but also from contaminated sediments. Estuaries and bays serve as a nursery ground for most of the young aquatic organisms.Since the immature forms are most sensitive to many kinds of environmental changes, excessive radioactive pollution could reduce fishery resources (RICE *et al.*, 1970). However a large number of marine biologists who are interested in the subject agree that the present radioactive contamination of the marine environment is not at a dangerous level.

In recent years, fast development and the increase in the number of nuclear power reactors, recent accidents and the use of radionuclides in medicine, industry and in scientific research have led to the production of radioactive wastes in large amounts. Ultimately much of this waste reaches the marine environment. For example, the Chernobyl accident on April 26, 1986 has released large quantities of radionuclides into the atmosphere. This contamination was widely distributed over most parts of Europe. This has given the hydrobiologist the possibility of investigating the fate of radionuclides in the mentioned ecosystem. Due to some characteristics of the marine environment which may dilute or disperse radionuclides, the concentration and localization of radioactivity is very important and requires periodic monitoring to be carried out in different locals (SCHREIBER,1971).During recent years, several regional monitoring studies have been carried out concerning radioactivity levels in different representative species and their Mediterranean environments (GEORGESCU, 1985; AKCAY, 1988, UYSAL, TUNCER, 1986; OZKAYA, 1992).

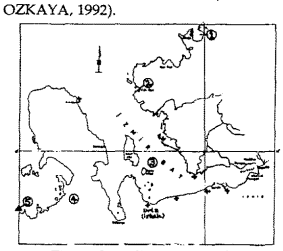

Fig. 1. Sampling stations (+)

In this investigation monitoring has been carried out for the determination of levels of natural gross beta radioactivity in the molluscs; *Mytilus galloprovincialis* Lam. *Tapes decessatus* L., *Cardium edule* L., *Patella* spp., *Venus verrucosa* L., *Natica millepunctata* Lam. and *Sepia officinalis* L. and their surrounding sediments from Izmir and Aliaga Bays. The specimens were collected from different polluted and unpolluted areas of Izmir and Aliaga Bays. The sampling stations are shown on the map in Fig. 1. All samples were washed using clean sea water for the removal of sands and other contaminating materials.

Then sample preparation and measurement procedures were performed according to our previous methods (UYSAL and TUNCER, 1986). All the data were corrected for ^{40}K.

The levels of natural gross beta radioactivity in the above mentioned species, which represent different biotopes and environmental conditions, are given in Table 1. As it can be seen from the Table, there are some variations in natural gross beta radioactivitiy between the species and localities. The concentrations of natural gross beta radioactivity in the molluscs of Izmir Bay are higher than those from the other locality.

Table 1. The levels of natural gross beta radioactivity of some Mollusc species and their sediments in Izmir and Aliaga Bays (Bq/g Ash).

Locality		Species	Ash W./ Wet W.%	Ash W./ Dry W.%	Bq/g
Aliağa Bay (1)		-Mytilus galloprovincialis Lam.	4.10	22.12	0.91
		-Tapes decussatus L.	6.38	33.86	0.51
		-Patella spp.	10.39	36.00	1.14
		-Natica millepunctata Lam.	5.73	31.84	0.36
		-Sepia officinalis L.	10.13	37.08	1.39
		-Sediment	26.73	42.68	0.99
Foça Harbour (2)		-Patella spp.	15.94	37.63	0.66
		-Sediment	38.58	45.56	0.81
Izmir Bay (3)	+Homa Fishery	-Mytilus galloprovincialis Lam.	15.91	29.97	0.95
		-Cardium edule L.	4.80	32.89	1.26
		-Patella spp.	5.16	24.08	1.83
		-Sepia officinalis L.	8.68	37.08	3.30
		-Sediment	20.06	39.41	0.95
	+Çaliburnu Fishery	-Tapes decussatus L.	6.94	44.77	1.08
	+Bostanlı (Karşıyaka)	-Tapes decussatus L.	8.13	43.01	1.51
		-Sediment	28.50	47.00	1.12
	+Çakalburnu Fishery	-Tapes decussatus L.	4.51	23.85	1.08
		-Venus verrucosa L.	4.96	30.84	1.33
	+Liman reis	-Mytilus galloprovincialis Lam.	3.41	25.35	1.04
		-Patella spp.	11.40	45.93	0.83
	+Kalabak	-Patella spp.	5.88	29.94	0.84
	+Urla (iskele)	-Patella spp.	10.38	38.52	0.33
	+Karaburun	-Patella spp.	12.56	44.47	1.22
		-Sediment	21.62	46.52	0.36
Ildır (4)		-Mytilus galloprovincialis Lam.	2.89	26.23	1.66
Çeşme Harbour (5)		-Patella spp.	6.38	45.40	1.69
		-Sediment	27.45	44.39	0.37

According to our present data the natural gross beta radioactivity of samples varied between 0.33-3.31 Bq/g Ash. There is correlation between radioactivity and discharged volumes and pollution levels in the Izmir and Aliaga Bays. In general, radioactivity was found in low levels and is in good agreement with regional studies performed previously (GEORGESCU *et al.*, 1984; UYSAL, TUNCER, 1986; PARLAK, 1983; AKCAY, 1988).

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Muscle lipids and protein content of the rabbit fish *Siganus rivulatus* (Forsk.) from the Southeastern Mediterranean

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Available published work on the biochemical composition of rabbit fish in general and *S. rivulatus* in particular is scanty (PEIRIS & GRERO, 1972). The present paper entails results of total lipid, total protein and water content of the muscles of juveniles (<15 cm total length) and adults (>25 cm total length) of both sexes of *S. rivulatus* from the Southeastern Mediterranean off the Egyptian coast. Biochemical analysis were carried out on monthly samples (covering a complete year) collected from Alexandria region. Total lipids were determined according to the method described by BLIGH & DYER (1959). Total protein was analyzed and assessed following the procedure of ASSEM & HANKE (1981); Egg albumin was used as a standard protein. All results are expressed as percent of wet weight.

The average water content in the muscles of *S. rivulatus* was 75.7% varying between 78% and 74% with no significant differences between both sexes and all lengths.

The lipid content of juvenile fish varied between 0.69% and 1.84% with an average of 0.91%. In adult fish, the lipid content was significantly higher and averaged 1.13% varying between 0.6% and 2.7%. In both juvenile and adult fish total muscle lipid was higher in females than in males but the differences were statistically not significant. Throughout the length range 17-28 cm the lipid content increased with increasing fish length, the correlation coefficient was significantly high (r=0.93). The low values of muscle fat content classifies the species among lean fishes which probably store their fat in the viscera. In *S. javis*, the highest amount of lipid (22.8%) occurred in the viscera against 3.8% in the flesh and 4.4% in the liver (PEIRIS & GRERO, 1972). The correlation between muscle lipid and water content was not significant, however, in fatty fishes, a significant inverse relation between muscle lipid and water content usually exists (LOVE, 1970). Seasonal variation in the muscle lipid of both juvenile and adult stages of the species was significant (Fig. 1). This variation was directly correlated with variation in the feeding intensity of the species in the study area (DOWIDAR *et al.*, 1972). Thus in juvenile stage the highest levels of muscle lipid occurred in spring and summer coinciding with the period of intensive food intake and the lowest in winter when feeding intensity is minimal. Likewise in the adult fish the maximum lipid content occurred in autumn during the peak of intensive feeding following the spawning season in summer; the latter season is characterized by low feeding intensity and low fat content. Variation in total lipid was directly correlated with corresponding variation in the hepato-somatic index in the fish (r=0.727). The reduction of muscle lipid content during May-July was accompanied with a similar drop in the value of hepato-somatic index. Both may be related to the spawning activity of the fish. The energy needed in the spawning season is probably taken from stored lipid in the muscle and liver (HENDERSON & ALMATAR, 1989).

In *S. rivulatus*, the mean values of the muscle protein were 19.6% (17-21.8%) and 21.2% (17.9-24%) in juvenile and adult stages, respectively. The muscle protein increased with increase in fish length. Throughout the length range 16-28 cm, a significant direct correlation (r=0.913) was found between total length and muscle protein. A significant inverse relationship was found between the protein and water content in the flesh of *S. rivulatus* (r=0.794). The monthly variations of protein and lipid contents in juvenile fish were positively correlated (r=0.87), both increased in spring and summer and decreased in autumn and winter (Fig. 2). These variations seem to reflect changes in feeding intensity in the different seasons (*vide supra*). In adult fish, the correlation between total muscle lipid and protein contents was also significant (r=0.706), both follow nearly the same trend of sensonal variation. The remarkable drop of muscle protein in both sexes was recorded in spring (prespawning period), while the maximum values occurred in Autumn, coinciding with maximum feeding intensity following spawning period. It appears that in lean fishes at least part of the energy required for gonadal development is obtained by mobilization of muscle protein (LOVE, 1970).

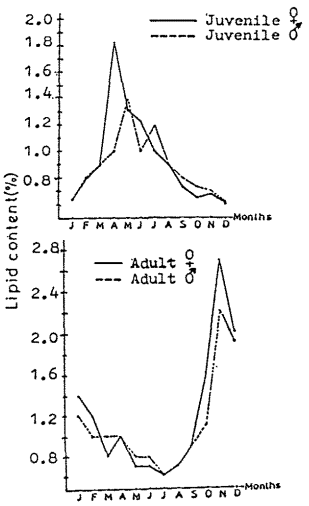

Fig. 1.- Monthly variation of muscle lipid content.

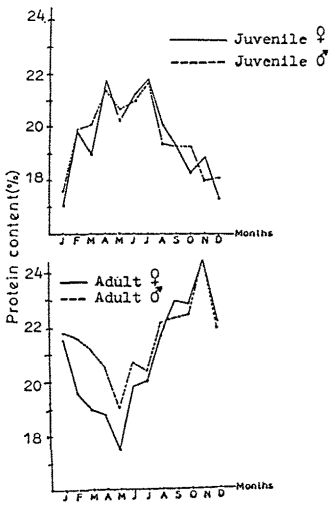

Fig. 2.- Monthly variation of muscle protein content.

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La croissance des juvéniles de merlu dans le Golfe du Lion : nouvelles méthodes d'approche

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La croissance du merlu en Méditerranée pose des problèmes importants, particulierement au cours de sa première année de vie. Ceci est dû à la fois à une période de ponte très longue se traduisant par un recrutement quasi-permanent et à une croissance individuelle très variable. Pour résoudre ces questions une étude en commun a été entreprise par des chercheurs impliqués dans le projet CEE/FAR "Etude pour l'aménagement et la gestion des pêches en Méditerranée occidentale".

Pour le golfe du Lion, cette étude est réalisée sur la base d'un échantillonnage conduit par IFREMER d'avril 1990 à mars 1991. Il a consisté en prélèvements mensuels d'otolithes à raison de 10 individus par classe de 5 cm, mais le présent travail ne prend en compte que les poissons de 10 à 20 cm. Une première lecture des otolithes entiers effectuée séparement par deux chercheurs espagnol et français n'a pas permis la determination de critères d'âgeage sûrs, malgré une très bonnne convergence des identifications d'anneaux, en raison de leur grande variabilité de structure.

Aussi a-t-il paru indispensable de compléter cette étude en utilisant d'autres méthodes :
- analyse de la croissance à partir de la microstructure des otolithes
- analyse des distributions modales de juvéniles dans les débarquements commerciaux en fonction du temps.

Etude de la microstructure des otolithes

Méthodologie

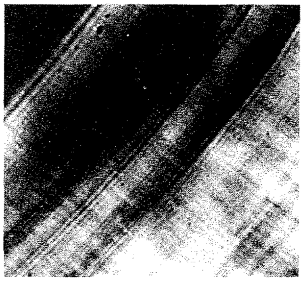
Pour chaque mois, quatre otolithes ont été traités après préparation selon 2 méthodes, les tailles extrêmes variant entre 10 et 18 cm :

. sections frontales réalisées après montage à l'Eukitt par polissages successifs jusqu'à obtention d'une surface aussi homogène que possible et éclaircissement dans l'huile à immersion pendant 48 heures,

. sections transversales de 500 mμ d'épaisseur après inclusion dans une résine puis collage sur support et polissage manuel.

Résultats

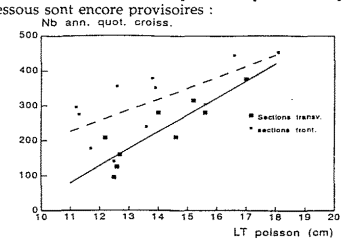
La totalité du matériel n'ayant pas encore été observée, les résultats fournis doivent être considérés comme provisoires.



Les otolithes de merlu présentent une structure nucléaire centrale constituée par des zones d'accroissements de 2 à 6 μm déposées à partir du focus. Autour de cette structure des nuclei de cristallisation et de croissance accessoires commencent à se former irrégulièrement. A partir de ces nuclei se développe une zone avec des structures de croissance larges et diffuses dont il est difficile de dénombrer les stries; lorsque débute la formation des lobules marginaux typiques de *Merluccius* la croissance se poursuit plus régulièrement.

La zone de lecture retenue en définitive pour les lectures est le rayon focus-bord dorsal quel que soit le type de section. Les sections transversales ont montré moins de discontinuités que les frontales mais la zone nucléaire était moins claire. Environ 75 % des sections ont pu être interprétés dans les deux cas. Des rythmes de regroupements de 2, 7 et 30 stries ont été observés, qui paraissent indiquer une périodicité diurne et peuvent correspondre à des variations du milieu liées au cycle lunaire.

Le nombre de stries d'accroissement montre une bonne relation avec la longueur du poisson malgré une certaine dispersion pour les petites tailles; cette relation est de type linéaire et a été calculée séparément pour les 2 types de sections. Les valeurs données ci-dessous sont encore provisoires :

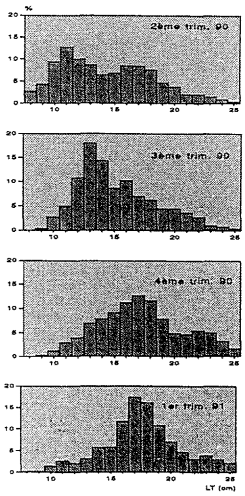


	Sect. Fr.	Sect.Tr.
coef. X	31.27	47.54
C^{ste} b	−118.7	−456.9
r	0.70	0.88

Ceci correspondrait à une croissance mensuelle moyenne de l'ordre de 1 cm.

Evolution des distributions modales de juvéniles

Les mensurations effectuées à la criée de Sète pendant la période avril 90-mars 91 permettent d'établir la structure en taille des débarquements par trimestre. L'analyse de l'évolution des modes pour les poissons de moins de 25 cm au cours de cette période apporte des éléments complémentaires sur l'accroissement trimestriel (cf. Fig. ci-contre).



Pour l'analyse de ces distributions, on a utilisé la décomposition en courbes gaussiennes (NORMSEP). Malgré une certaine hétérogénéité, liée sans doute à des recrutements partiels très rapprochés dans le temps, on peut suivre aisément l'évolution du premier mode d'un trimestre à l'autre : elle traduit une croissance mensuelle de 1 cm environ, plus forte en été et au début de l'automne, très ralentie en hiver. Le deuxième mode quoique moins apparent montre une évolution et un taux de croissance similaires.

Les deux méthodes utilisées donnent des résultats comparables quant au taux de croissance des juvéniles. A la fin de l'étude en cours, la confirmation de ces premiers résultats devrait permettre d'apporter des éclaircissements certains sur le problème de la croissance des jeunes merlus.

V

Differences in Sardine (*Sardina pilchardus* Walbaum) growth among the several areas in Mediterrannean Iberian Peninsula and Golfo de Leon Shelf

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Hydroacoustic surveys have been carried out yearly (except at 1986 and 1989) by the IEO in order to estimate the biomass of pelagic fish populations from Mediterranean Iberian Peninsula and Golfo de Leon shelf (1).

4142 pairs of sardine sagitta otoliths, belonging to specimens sampled at the different prospected areas during these cruises, have been readed using standard techniques (2). The age assigned to each specimen was its year class plus year fraction from 1st January to the sample day.

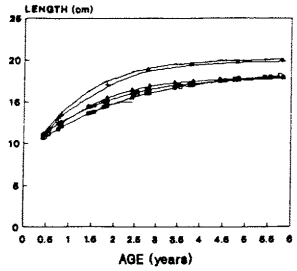
Data from the whole of surveys, including year classes range 0-5, were used jointly to estimate Von Bertalanffy growth parameters at each zone. Cataluña was not included in the study because of the scarcity of samples.

Number of analised specimens is detailed in table 1. Growth curves of the different zones can be seen in fig.1. Estimated growth parameters appear in table 2. As L and K values are correlated, Phi values (3) were calculated (table 4) to obtain the growing performance of the populations in the diverse areas.

In order to know the statistic significance of the differences, Hotelling's T2 test (alfa=0,001) was applied (4). Relative significance among parameters was estimated using Roy-Bose simoultaneous confidence intervals (4).

The test results (table 5) showed that sardine growth in those areas differ significatively. However Alboran and Vera Gulf are closely related, as well as Alicante, Valencia and Leon Gulf areas are also related among them.

These data would indicate that there are not important migrations of sardine populations along Mediterranean Iberian Peninsula Shelf. The significative differences in sardine growth among so geographically proxime zones could be explained by several hypothesis, like variations in primary productivity, genetic characteristics or birthdate of recruits at each area. Further studies will be carried out to correlate sardine growth with those parameters.



-Fig.1-GROWTH CURVES.

	0	I	II	III	IV	V	VI+	TOTAL
ALBORAN	697 (7)	173 (6)	94 (5)	25 (5)	20 (5)	3 (3)	2 (2)	1014
G.VERA	249 (6)	31 (2)	23 (3)	21 (3)	14 (3)	6 (1)	5 (3)	349
ALICANTE	574 (7)	316 (7)	98 (7)	17 (5)	10 (5)	2 (2)	1 (1)	1018
VALENCIA	438 (7)	330 (7)	149 (6)	77 (6)	25 (5)	9 (3)		1028
CATALUÑA	314 (4)	66 (3)	12 (1)	6 (1)				398
G.LEON	185 (2)	60 (3)	39 (3)	31 (3)	23 (3)	16 (3)	1 (1)	335
TOTAL	2437	976	415	177	92	36	9	4142

TABLE 1-NUMBER OF ANALISED SPECIMENS BY AGE CLASS AND ZONE.

ESTIMATES OF GROWTH PARAMETERS

	L	K	To
ALBORAN	20,148	0,861	-0,504
GOLF.VERA	19,921	0,836	-0,506
ALICANTE	18,102	0,611	-1,119
VALENCIA	18,932	0,446	-1,409
GOLF.LEON	18,121	0,752	-0,731

TABLE 2-ESTIMATED VON BERTALANFFY GROWTH PARAMETERS.

	Φ VALUES
ALBORAN	5,86
GOLF.VERA	5,80
ALICANTE	5,30
VALENCIA	5,07
GOLF.LEON	5,51

TABLE 3-PHI VALUES.

T2 VALUES(To=17,7)

	GOLF.VERA	ALICANTE	VALENCIA	GOLF.LEON
ALBORAN	4526	182101	189050	86993
GOLF.VERA		57999	62053	24133
ALICANTE			7454	5234
VALENCIA				10335

TABLE 4-HOTELLING'S T2 VALUES.

RELATIVE SIGNIFICANCE AMONG PARAMETERS

		(P1-P2)	CONF.INT.	CRITIC.Fo
ALB/G.VERA	L	0,2271		24,5
	K	0,0246	+/-0,2630	4,5
	To	0,0025		0,0
ALB/ALC	L	2,0458		8869,8
	K	0,2599	+/-0,1719	3549,9
	To	0,6149		23514,0
ALB/VAL	L	1,2162		769,2
	K	0,4153	+/-0,1866	3037,6
	To	0,9048		4633,7
ALB/G.LEON	L	2,0268		2308,1
	K	0,1090	+/-0,2659	98,7
	To	0,2271		257,2
G.VERA/ALC	L	1,8188		227,4
	K	0,2255	+/-0,2628	163,3
	To	0,6125		398,0
G.VERA/VAL	L	0,9691		24,9
	K	0,3907	+/-0,2625	715,5
	To	0,9023		840,4
G.VER/G.LEON	L	1,7997		861,4
	K	0,0844	+/-0,3239	66,4
	To	0,2248		231,1
ALC/VAL	L	0,8297		312,5
	K	0,1652	+/-0,1863	3,0
	To	0,2899		570,3
ALC/G.LEON	L	0,0191		0,2
	K	0,1411	+/-0,2657	222,0
	To	0,3878		428,0
VAL/G.LEON	L	0,8106		256,4
	K	0,1063	+/-0,2654	1718,3
	To	0,6777		2096,8

TABLE 5-ROY-BOSE SIMOULTANEOUS CONFIDENCE INTERVALS.

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V

Contribution to the knowledge of growth of Greater Amberjack, *Seriola dumerili* (Cuv. , 1817) in the Sicilian Channel (Mediterranean Sea)

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Des études sur l'évaluation du stock et la biologie de la Sériole couronnée ont été effectuées en 1989, 1990 et 1991 dans le Canal de Sicile. L'étude de l'âge et de la croissance de l'espèce fait partie des objectifs de cette recherche. La corrélation taille-poids obtenue est la suivante : $W = 0.000049\ SL^{2,723}$. L'évaluation de l'âge, effectuée par la lecture des écailles a permis de séparer 8 classes d'âge ; on n'a pas considéré nécessaire de séparer les deux sexes pour ce qui concerne la croissance. Les paramètres de von Bertalanffy sont les suivants: L_{oo} (cm) = 167; t_o = -0.770; K = 0.1850.

In a research programme on the biology and the stock assessment of Greater Amberjack, the growth of this species has been studied. This species is interesting for Italian fishery because it is an important underexploited resource. It is very important for mariculture because it is possible to obtain high growth value in a short time. Greater Amberjack is a cosmopolitan fish with a large distribution in the world. This species is catched by fishermen using trammel net and purse seine but the sportive capture carried out mainly on the juvenile by trolling is not trascurable.

The investigation area was the South Tirrhenian Sea and the Sicilian Channel but the data used in the present work are coming only form south Lampedusa island fishing zone (fig. 1) because in relation with preliminary data it is possible to suppose that we have not one unit stock in the whole area.

According to LAZZARI (1988), this zone resulted the main spawning area in the Sicilian Channel.

In the three year investigations (1989, 90, 91) 4800 length and weight data were collected in landings and 1140 specimens ranging between 35 cm and 167 cm of standard length, were sampled, by rent professional fishing vessel using purse seine.

Standard length were preferred to total length because working on bif fishes in commercial catches the first one is more precise and easy to mesure, the tail beeing broken in many specimens.

The size frequency histograms are showed in fig. 2. In each sample, biometrical and weigth measurement have been recorded, sex and gonadic maturity determined and scales collected. In some specimens otoliths and vertebra have been collected too for comparative readings, the scales resulted more clear and easy to read.

The length-weight relationship has been calculated : $W=0.000049\ SL^{2,723}$.

Thus, we can identify 8 age-groups up to 142 cm because the bigger specimens were too rare to be employed for a correct age determination.

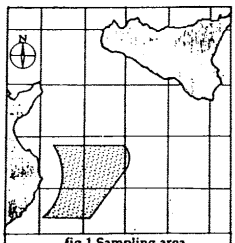

fig 1 Sampling area

The parameters of von Bertalanffy's growth equation have been calculated : L_{oo} = 167; T_o = -0.770; K = 0.1850.

Growth curves were calculated separately for the two sexes but there are not significative differences between males and females so, just one growth curve is proposed (fig. 4).

Since samplings have been always carried out during the spawning period, each agering correspond to a real fish year life.

In litterature there are not references for wild Greather Amberjack age determination but only for growth obtained in mariculture or for the other species of the genus.

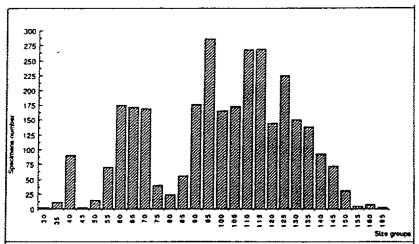

FIG. 2: SIZE FREQUENCY IN SAMPLING YEARS (1989/90/91)

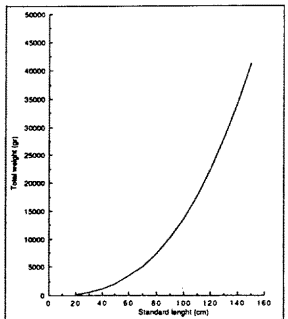

FIG 3 LENGHT - WEIGHT RELATIONSHIP

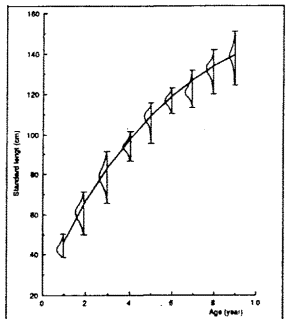

FIG 4 GROWTH CURVE

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Contribution to the knowledge of the age and growth of Large-Eye Dentex, *Dentex macrophthalmus* (Bloch, 1791) in the African continental shelf of the Sicilian Channel (Mediterranean Sea)

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Deux prospections par chalutage ont été réalisées en 1982 et 1983 dans le Canal de Sicile, en utilisant des bateaux et engins de pêche professionnels; 102 traits de chalut ont été effectués à des niveaux bathymétriques et bionomiques différents. La croissance des spécimens de denté à gros yeux capturés a été étudiée. La corrélation taille-poids obtenue a été : Wt=0,0000076Tl^{3,138} et les paramètres de croissance calculés par la méthode de von Bertalanffy sont les suivants : L_{∞} (mm)=257; K=0.245; t_0=-0.457.

Within a research program on trawl fishery in the Sicilian Channel, two experimental surveys were carried out by ESPI (Ente Siciliano per la Promozione Industriale) in 1982-83 on the North African side of the mentioned area. A total number of 102 hauls were by using professional vessels and gears. The hauls have been performed in four sampling areas, characterized by bottom depths between 58 and 642m. Good catches of *Dentex macrophthalmus* were observed on epibathyal bottoms in the 200/300 m depth range covered with sand and mud and characterized by *Funiculina quadrangularis* and *Terebratula vitrea* facies (sub area C fig. 1). On the whole, 1654 specimens were sexed, measured and weighed (respectively to the lower mm and g), TLs ranging from 54 to 225 mm (fig. 2). The length-weight relationship result to be properly described by the curve. Wt=0,0000076Tl^{3,138} (fig. 3).

Age reading has been done on sagitta and scales : the latter being used in few cases for comparison only because otolith result more clear and easy to read. A total number of 520 otoliths were read on dark ground by using reflected light and 1:1 alcohol/glycerine solution as clearing substance. Six age groups were determined, a single growth was defined by combining females and males, since sex differences (if any) seemed of limited extension.

The parameters if von Bertalanffy length-growth equation have been calculated as : L_{∞}=257; K=0.245; t_0=-0.457.

Our results differ from those observed by TRUNOV (1972) and KUNDERSKAYA (1984) for Southeast Atlantic *Dentex macrophthalmus*. Indeed, both the authors identified in the otoliths and in the scales two rings per year, but in the Mediterranean specimens used in our study, rings seem to be laid down a year, this maybe in relation to different environment conditions.

In our sampled specimens the formation of two separate rings per year was excluded because the well separated several length groups (fig. 2) probably originate from different spawning seasons and *D. macrophthalmus* in the investigation area, it is known to reproduce in September (BINI, 1968); this is in accordance to our direct observation since most fishes caught in October were in postdepositional gonadic stages.

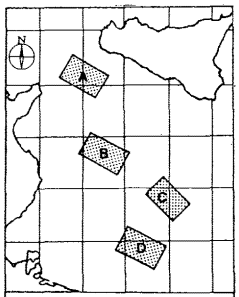

fig. 1 Sampling areas

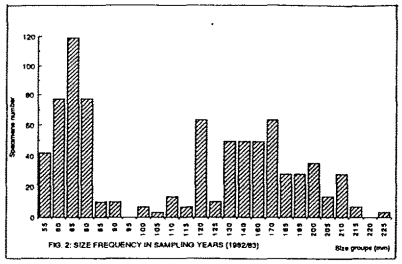

FIG. 2: SIZE FREQUENCY IN SAMPLING YEARS (1982/83)

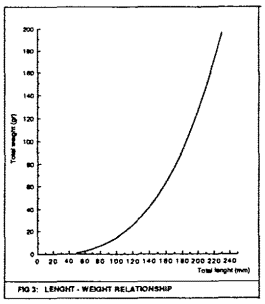

FIG 3: LENGHT - WEIGHT RELATIONSHIP

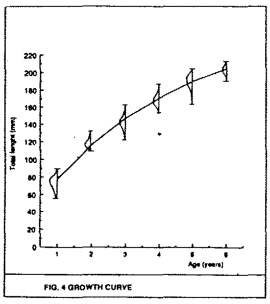

FIG. 4 GROWTH CURVE

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Contamination par le Mercure du dauphin *Stenella coeruleoalba* le long du Littoral Méditerraneen Français

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Le mercure a été déterminé par activation neutronique (AUGIER *et al.*, 1991) chez 18 dauphins *Stenella coeruleoalba* Meyen prélevés morts échoués le long du littoral méditerranéen français (tableau 1).

N°	Date	Site	Sexe	P./ L.	Collecteur
1	29/12/88	Golfe de Fos	F	68/170	Charreire
2	11/01/89	Golfe de Fos	M	77/175	Charreire
3	29/11/89	Golfe de Fos	M	95/191	Charreire
4	nc /90	nc	nc	nc	M.H.N.M...
5	nc /90	nc	nc	nc	M.H.N.M...
6	01/10/90	Sausset	M	91/203	M.H.N.M...
7	30/09/90	Cassis	M	79/195	M.H.N.M...
8	22/09/90	Méjean	F	nc/197	M.H.N.M...
9	01/11/90	Frioul	F	100/220	Dhermain
10	26/10/90	Six-Fours	F	87/203	Bompar
11	18/10/90	La Capte	M	75/185	Bompar
12	24/09/90	Hyères	M	83/206	Bompar
13	11/10/90	Sainte-Maxime	F	68/183	Bompar
14	09/12/90	Marseille	M	115/204	Dhermain
15	16/01/91	Carnon	F	74/187	Bons
16	09/11/90	Sète	M	43/160	Bons
17	11/11/90	Sète	M	nc/180	Bons
18	24/11/90	Cap d'Agde	F	nc/203	Bons

Tab. 1 : Caractéristiques principales des 18 dauphins échoués ; P. = Poids (Kg), L. = Longueur (cm), M. H. N. M. = Muséum d'Histoire Naturelle de Marseille, nc = non-communiqué.

Les analyses (tableau 2) ont révélé une contamination considérable de ces dauphins par le mercure, avec des variations en fonction du lieu d'échouage, des organes et des individus. Les tissus les plus contaminés sont ceux du foie (87 à 2909 µg/g), puis des poumons (4 à 508 µg/g), des reins (18 à 437 µg/g), de l'encéphale (4 à 259) et des muscles (6 à 199 µg/g).

Au plan toxicologique, en l'absence d'expériences de contamination in vitro, interdites par la loi, les doses létales ne sont pas connues. Il n'est par conséquent pas possible de dire avec certitude que le mercure est à l'origine de la mort des dauphins, d'autant plus que ces animaux peuvent développer des phénomènes de neutralisation de la toxicité des métaux à l'aide du sélénium ou/et des métallothionéines (MARTOJA et VIALE, 1977).

On peut cependant raisonnablement penser que des contaminations aussi élevées en mercure dans les organes vitaux doivent profondément perturber la physiologie de ces animaux. En pathologie, il est admis que le fait de trouver des teneurs élevées d'une substance toxique dans d'autres tissus en plus de ceux du foie est un signe d'intoxication. Ce constat est renforcé par les concentrations importantes dans l'encéphale, sachant que la caractéristique de l'intoxication par le mercure est une névropathie qui se révèle généralement à des taux bien plus faibles. On peut également situer les valeurs extrêmes dans le foie et l'encéphale par rapport à la dose maximale admissible de mercure dans les produits de la mer (0,5 ppm) et dans le thon (0,7ppm).

N°	Coeur	Encéphale	Foie	Graisse	Melon	Muscles	Peau	Poumons	Reins
1	9	6	208	0,5	1,2	13	-	10	18
2	5	4	87	-	0,7	10	-	4	37
3	11	29	408	1,0	-	29	-	52	24
4	32	49	1366	2,5	13,1	55	8	121	138
5	129	-	2909	3,9	13,6	199	25	508	437
6	31	29	622	2,1	10,7	49	16	102	99
7	42	29	690	1,8	10,5	60	12	80	81
8	64	47	1304	2,0	7,7	65	8	162	185
9	21	-	230	2,0	-	20	7	17	55
10	43	92	1375	2,0	19,1	95	17	300	83
11	60	108	1013	2,9	24,1	101	17	256	196
12	16	24	511	2,4	13,1	20	8	20	42
13	43	67	639	3,7	6,1	49	19	120	87
14	9	4	126	0,8	5,4	10	8	12	23
15	107	259	2470	4,0	17,2	148	36	469	229
16	79	93	318	1,4	4,6	55	22	109	116
17	11	4	91	0,4	1,1	6	6	9	35
18	25	11	284	1,2	1,0	13	9	67	56

Tab. 2 : Taux (µg/g de poudre lyophilisée) de mercure dans les principaux tissus des 18 dauphins bleus et blancs.

Ces resultats soulèvent une fois de plus le danger de la concentration des polluants le long des chaînes alimentaires en Méditerranée où les eaux ont été depuis longtemps reconnues comme étant plus chargées en mercure que celles de l'océan (BACCI, 1989, AUGIER *et al.*, 1992).

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V

Variation de la composition élémentaire et de la contamination métallique de la peau du dauphin *Stenella coeruleoalba*

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[b]Groupe d'Etudes des Cétacés de Méditerranée (CEGEM), MONTPELLIER (**France**)

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Les taux d'Ag, As, Au, Ba, Br, Ce, Co, Cr, Cs, Fe, Hg, K, La, Na, Rb, Sb, Sc, Se, Sm, Th, U, et Zn ont été déterminés par activation neutronique (AUGIER *et al.* 1991) dans la peau de 15 dauphins *Stenella coeruleoalba* Meyen prélevés morts échoués le long du littoral méditerranéen français (AUGIER *et al.*, 1992). Leurs valeurs moyennes, minimales et maximales, ainsi que l'écart type sont présentés dans le tableau 1.

Eléments	Symbole	Minimum	Maximum	Moyenne	Ecart-type
Antimoine	Sb	0	<0,21	<0,05	-
Argent	Ag	0	0,15	<0,08	-
Arsenic	As	0,39	4,96	1,96	1,27
Baryum	Ba	0	<35,2	<2,35	-
Brome	Br	28,0	71,1	42,3	11,2
Cérium	Ce	0	1,14	0,25	0,35
Césium	Cs	0	<0,25	0,05	0,09
Chrome	Cr	0	1,75	0,22	0,57
Cobalt	Co	0	0,28	0,11	0,08
Fer	Fe	0	141	43	46
Lanthane	La	0	<0,42	<0,07	-
Mercure	Hg	6,0	36,4	14,6	8,3
Or	Au	0	<0,01	<0,01	-
Potassium	K	1805	8183	4465	1595
Rubidium	Rb	0	3,80	2,20	0,93
Samarium	Sm	0	0	0	-
Scandium	Sc	0	0,01	<0,01	-
Sélénium	Se	19,6	180,4	80,3	45,1
Sodium	Na	3118	13030	6395	2767
Thorium	Th	0	<0,07	<0,01	-
Uranium	U	0	<0,80	<0,06	-
Zinc	Zn	291	1141	612	266

Tab. 1 : Concentration (µg/g de poudre lyophilisée) des éléments dans la peau du dauphin bleu et blanc, *Stenella coeruleoalba*.

Dans une étude précédente concernant l'interaction entre Hg et Se (AUGIER *et al.*, 1992), nous avons signalé le comportement différent de la peau par rapport aux autres organes et tissus tels que le foie, les reins, les poumons, le coeur, l'encéphale, les muscles, le melon et la graisse. A ce sujet, nous avions émis l'hypothèse que cette différence pouvait être en relation avec la pénétration transdermique des éléments contenus dans l'environnement aquatique des dauphins.

Malgré la forte attirance réciproque du Hg et du Se (THORLACIUS-USSING et DANSCHER, 1985), la corrélation non significative dans la peau (rappelons que les autres organes et tissus étudiés ont tous une corrélation positive significative) signifierait que la majeure partie du sélénium se trouve dans la peau sous une forme différente de Se^{2+}, non disponible pour le Hg (AUGIER *et al.*, 1992). Les quantités de Se beaucoup plus importantes que celles du Hg dans la peau (alors que c'est l'inverse pour les autres organes et tissus sauf pour la graisse) militent également en faveur de cette hypothèse.

Ce phénomène peut etre clarifié par une étude de corrélation des éléments dans la peau. Le test d'association entre les éléments à l'aide du coefficient de corrélation des rangs de Spearman montre que Se est (au seuil de l'erreur 5%) fortement lié à Br, Na, K, Rb, et Zn, et Hg à As. Ces corrélations montrent définitivement que Se dans la peau n'a pas de lien avec les produits de l'interaction entre Se^{2-} et les métaux. Grâce à ces résultats et en considérant les quantités considérables de Se dans la peau, le Se viendrait de l'eau de mer par la voie transdermique et Na, K, Rb et Zn joueraient un rôle non négligeable, peut-être même important, dans la capture du Se.

Par ailleurs, la relation existant entre Hg et As dans la peau de dauphin, ne semble pas avoir été rapportée et nous avons donc calculé l'équation de régression : (Hg) = 6,69 (As) + 2,36. La valeur 6,69 de la pente de l'équation correspond à 2,50 du rapport moléculaire de Hg/As, c'est-à-dire que 5 atomes de Hg sont liés aux 2 atomes d'As. La forme chimique et le mécanisme de formation du complexe formé à partir du Hg et As dans la peau de dauphin reste donc à établir.

L'ensemble de ces résultats soulève une fois de plus l'intérêt de prendre en compte la peau des dauphins pour connaître l'origine de certains éléments tels que Se.

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Etude histologique de l'ovogénèse et du cycle ovarien du Céteau des Côtes Algériennes, *Dicologoglossa cuneata* (Moreau 1881), Poisson Téléostéen, marin Soleïdae

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L'analyse histologique de l'ovaire du Céteau a mis en évidence six stades ovocytaires déterminés par (DENIEL *et al.*, 1989 et BELAID *et al.*, 1983) en fonction des principales modifications observées au cours de l'ovogenèse, ovocytes méïotiques exclus (voir tableau) .

Par ailleurs, le céteau présente une reproduction cyclique (annuel) imposant à la gonade des transformations morphologiques et structurales décrites en quatre stades (ovaire immature, mature ou en vitellogenèse, en post-ponte, et au repos sexuel).

A.- Etude histologique de l'ovogénèse

1. Ovocytes méïotiques: Ce sont des cellules de petite taille de 8 à 12 µm constituées d'un gros noyau à nucléole unique et d'un cytoplasme peu volumineux. Elles sont regroupées en nids, ou isolées à la périphérie des lamelles ovariques.

2. Evolution des stades ovocytaires

STADES	ETAT	ASPECT MICROSCOPIQUE	Ø max µm	RNP
I. Stades prévitellogenétiques	Ovocyte primaire (OVO A.)	Nucléaires centraux Cytoplasme homogène	46 µm	0,60
II.	Ovocyte immature (OVO B.)	Nucléoles nombreux périphériques cytoplasme homogène en accroissement lent	82 µm	0,50
III. Stades vitellogenétiques à vitellogenèse endogène	ovocyte à vitellogenèse primaire (OVO C.1)	cytoplasme hétérogène près du noyau début apparition de vacuoles claires (inclusions lipidiques) + vacuoles corticales périphériques Zone pellucide visible	182 µm	0,40
IV.	ovocyte à vitellogenèse secondaire (OVO C.2)	Cytoplasme hétérogène avec 3 zones : périphérique, trabéculaire et périnucléaire vacuoles claires disposées en couronne	210 µm	0,25
V. Stade vitellogenétique à vitellogenèse exogène	Ovocyte vitellogenèse tertiaire (OVO D.1)	granules vitellins apparaissent et occupent progressivement la zône trabéculaire enveloppes ovocytaires visibles (D.1)	300 µm	0,21
	(OVO D.2)	cytoplasme chargé de globules vitellins masquant les autres inclusions zone pellucide atteint son épaisseur maximale (D.2)	470 µm	0,10
VI. ovocyte hyalin		coalescence des inclusions, vitellus hyalin, augmentation du diamètre ovocytaire noyau excentré, zone pellucide moins épaisse	620 µm	

B.- Etapes du cycle ovarien du Céteau

1. Ovaire immature. Il est caractérisé par la présence d'ovocytes méïotiques, d'ovocytes primaires (stade I) et immatures (stade II). Ces ovocytes sont contenus dans les lamelles ovariques régulièrement agencées dans la cavité ovarienne.

2. Ovaire mature ou en vitellogénèse. Chez le céteau, les premières pontes sont printanières. Le début de la vitellogénèse est perceptible dès le mois de décembre. En histologie, elle est reliée au déroulement des premières étapes de la vitellogénèse et non à une augmentation du nombre d'ovocytes. Au cours de la vitellogénèse apparaissent les ovocytes à vitellus endogène (stades III et IV), puis exogène (Stade V D_1 et D_2). Les ovocytes s'accroissent atteignant une taille maximale juste avant la ponte. Ils traduisent la fin de la maturation ovocytaire (stade VI) caractérisé par la migration du noyau et la liquéfaction du vitellus .

Ces ovocytes mesurent alors 600 µm.

Chez *D. cuneata*, l'entrée en vitellogénèse des ovocytes est asynchrone. Les processus d'ovogénèse sont continus et plusieurs lots (3 à 4) s'individualisent successivement.

3. Ovaire en post-ponte. C'est un ovaire qui contient des follicules post-ovulatoires (ponte récente) dont la durée de vie est très brève (24 heures) et de nombreux ovocytes atrétiques. Pendant la resorption de ces restes de ponte, le stock de jeunes ovocytes (stades I et II) se reconstitue. L'ovaire entre dans une phase de repos.

4. Ovaire au repos. Il a le meme aspect que l'ovaire immature. Il s'observe chez les femelles adultes dont la taille est supérieure à 16 cm et présente quelques ovocytes du stade III et de nombreux ovocytes en prévitellogénèse. Ces ovocytes constituent le stock de réserve destiné aux pontes futures.

Conclusion

L'ovogenèse du céteau débute en mars. La définition des stades ovocytaires est arbitraire et l'évolution de l'ovocyte est un phénomène continu et complexe. C'est pendant la prévitellogénèse que l'ovocyte acquiert les potentialités d'accumuler des réserves autosynthétiques (lipides, alvéoles corticales) et chez chaque femelle, la vitellogénèse se déroule en 3 ou 4 lots (donc 2 à 3 cycles de pontes) au cours de la période d'activité sexuelle. Ce phénomène est fréquent chez les Soleïdae. *D. cuneata* est donc une espèce à ponte fractionnée.

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V

Importance des éléments du squelette axial dans la systématique des poissons: application aux espèces du genre *Trachurus* Rafinesque, 1810 (Poissons, Carangidae)

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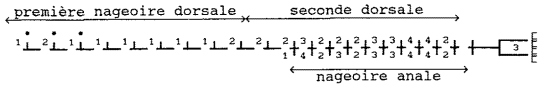
Importance of skeletal axial elements in pisces systematics: application to species of genus *Trachurus* (pisces, Carangidae). A study of the axial system and its relation with odd flipper rays permits to state axonostic formulae for each species and the use of the axonostic mean in pisces systematic.

Introduction. Depuis les travaux de NICHOLS (1920), plusieurs auteurs ont contribué à la résolution du problème systématique posé par les *Trachurus*, en proposant des révisions qui sont souvent fondées sur les méthodes phénétiques classiques, et ont abouti à la création d'espèces ou sous-espèces nouvelles. Nous avons appliqué, pour la première fois, les nouvelles méthodes d'analyse multidimensionnelles à la taxinomie numérique des *Trachurus* et sommes arrivés à reconnaître 14 espèces du genre (BEN SALEM, 1988). Depuis, l'étude ostéologique du système axial de ces poissons faite par examen radiographique, a permis d'apporter des éléments nouveaux dans la systématique des *Trachurus*.

Formule axonostique. Comme le nombre de vertèbres chez les espèces du genre *Trachurus* est constant et égal à 24, nous avons essayé d'établir les formules axonostiques dont l'intérêt systématique a été signalé pour la première fois par BLOT (1984) dans ses études paléontologiques de l'ichtyofaune de Monte Bolca.

Il s'agit de représenter les relations entre le squelette axial et le squelette des nageoires impaires, dorsales et anales. Nous comptons le nombre d'axonostes dans chaque espace interneurapophysaire, dorsalement, et hémapophysaire, ventralement. Les dernières vertèbres caudales forment le "complexe urophore" (MONOD, 1968). Dans la formule axonostique les axonostes auxiliaires ou inermes sont dôtés d'une étoile.

La formule axonostique des *Trachurus* se présente de la manière suivante:



Inclinaison vertébrale. Nous avons mesuré sur la radiographie de chaque poisson l'inclinaison des épines hémales et neurales des première et deuxième vertèbres caudales. Pour les vertèbres thoraciques l'aplatissement de certaines d'entre elles rend difficile la mensuration de l'inclinaison des épines neurales et hémales. Nous proposons alors de prendre la première et la deuxième vertèbres caudales comme repère pour déterminer ce que nous appelons l'inclinaison spécifique. Pour échapper au phénomène d'allométrie il faut mesurer les inclinaisons spécifiques chez des spécimens adultes.

Discussion. L'étude de la distribution des axonostes au niveau des vertèbres thoraciques montre que pour le même genre il existe une fluctuation assez importante dans la répartition des axonostes. Cette fluctuation s'observe surtout au niveau des 7ème, 8ème et 9ème vertèbres thoraciques qui donnent le maximum d'informations dans l'étude systématique.

La répartition des axonostes nous permet de distinguer trois espaces interapophysaires :

- les espaces interapophysaires possédant des axonostes dont la répartition est systématiquement significative: ce sont les espaces des vertèbres thoraciques 7, 8 et 9 et des vertèbres caudales 11, 12, 13, 14, 15, 16, 17, 18 et 19, et ceci aussi bien du côté dorsal que du côté ventral.
- les espaces interapophysaires possédant des axonostes dont la répartition n'a aucun intérêt systématique; ce sont les espaces des vertèbres thoraciques 1, 2, 3, 4, 5 et 6.
- les espaces interapophysaires sans axonostes; il s'agit des espaces des vertèbres 20 et 21; derrière ces deux vertèbres nous trouvons le complexe urophore sans axonostes.

Nous remarquons que le maximum de ressemblance dans la répartition des axonostes s'observe chez les couples suivantes: *T. iaponicus* et *T. novaezelandiae*; *T. symmetricus* et *T. picturatus*; *T. murphyi* et *T. declivis*; *T. trecae* et *T. lathami*; *T. ponticus* et *T. mediterraneus*: *T. indicus* et *T. trecae*; *T. delagoa* et *T. trecae*.

Les résultats que nous venons de trouver dans l'étude systématique des *Trachurus* confirment les parentés que nous avions mises en évidence en étudiant les variables méristiques (BEN SALEM, 1988).

Sur le plan pratique, nous avons remarqué l'isolement ostéologique de l'espèce *T. capensis* qui d'après les autres méthodes montrait beaucoup de parenté avec l'espèce *T. trachurus*. La divergence entre ces deux espèces est donc à chercher au niveau du squelette et non au niveau des variables numériques et métriques.

Dans l'étude axonostique d'une espèce donnée, nous proposons de calculer la moyenne axonostique; ainsi chaque espèce sera caractérisée non pas par la répartition des axonostes mais par la moyenne des axonostes au niveau de chaque espace interapophysaire

L'inclinaison de l'épine neurale de la première vertèbre caudale nous permet de distinguer *T. declivis* qui présente une épine fortement inclinée. L'espèce *T. murphyi* caractérisée par une épine hémale faiblement inclinée.

De même que pour les axonostes, l'inclinaison spécifique des épines chez les différentes espèces du genre *Trachurus* a permis de faire certains regroupements et déterminer une parenté certaine entre *T. novaezelandiae*. *T. iaponicus* et *T. lathami*. Nous avons pu mettre en évidence ces regroupements par une analyse des correspondances (BEN SALEM, 1991).

Conclusion. L'étude ostéologique nous a permis surtout d'introduire des notions nouvelles en ostéologie telles que la moyenne axonostique et l'inclinaison spécifique des épines neurales et hémales.

L'étude axonostique a permis de mettre en doute la portée générale de la formule utilisée par BLOT (1984). Cet auteur considère en effet qu'une étude axonostique doit tenir compte du nombre et de la disposition des axonostes auxiliaires (ou inermes), du nombre des premiers axonostes correspondant aux vertèbres thoraciques et de leur disposition, enfin de la disposition des axonostes et de leur nombre dans la région du complexe hémaxanal.

Il serait alors beaucoup plus logique de déterminer le pouvoir discriminant de chaque variable que de limiter l'intérêt de l'étude axonostique aux axonostes de certaines régions du corps.

L'inclinaison des épines des vertèbres peut avoir un intérêt systématique particulier.

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Les captures accidentelles de *Caretta caretta* au chalut benthique dans le Golfe de Gabès

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Environ 300 chalutiers, rattahés au port de Sfax, travaillent essentiellement dans la région du golle de Gabès. La crevette *Penaeus kerathurus* est l'espèce vitale pour ce type de pêche. Elle est capturée principalement du 10 mai au 31 juillet dans les zones A et B (1ère campagne) et du 15 octobre au 15 décembre de chaque année dans la zone C (carte 1). Le chalut utilise durant toute l'année, pour la pêche des poissons et des crevettes, est un chalut de fond dont la forme générale rappelle celle d'un chalut floridien. Il est constitué de 4 faces ayant pratiquement le même maillage.

Le chalutage benthique dans cette région engendre une capture accidentelle importante de tortues marines *Caretta caretta*.

Importance des captures accidentelles

Aux mois de juin et juillet 1991, nous avons effectué deux campagnes de chalutage expérimental dans les zones à crevettes, au cours desquelles nous avons capturé une seule tortue. Par ailleurs, au cours des 1569 debarquements enregistrés et suivis par les services de l'INSTOP dans le port de Sfax, 10 tortues ont été déclarées durant la 1ère campagne de pêche à la crevette 1991. Nous pouvons estimer le nombre total des tortues capturées au cours de cette 1ère période à une vingtaine.

En dehors de cette première campagne de pêche à la crevette, les captures de *Caretta caretta* sont réalisées principalement dans les zones mentionnées sur la carte n°1. 67,74% des prises sont réalisées aux mois de novembre, décembre et janvier. A Ras Zira et à Banc Griguo, un chalutier pêche 4 à 5 et jusqu'à 12 tortues par sortie. Nous pouvons estimer les captures et recaptures annuelles à 2000-2500 tortues.

Les tortues arrivent généralement vivantes à bord, continuent à vivre normalement après leur relachement immédiat ; c'est une pratique devenue très fréquente suite à l'interdiction de leur commercialisation dans les marchés municipaux.

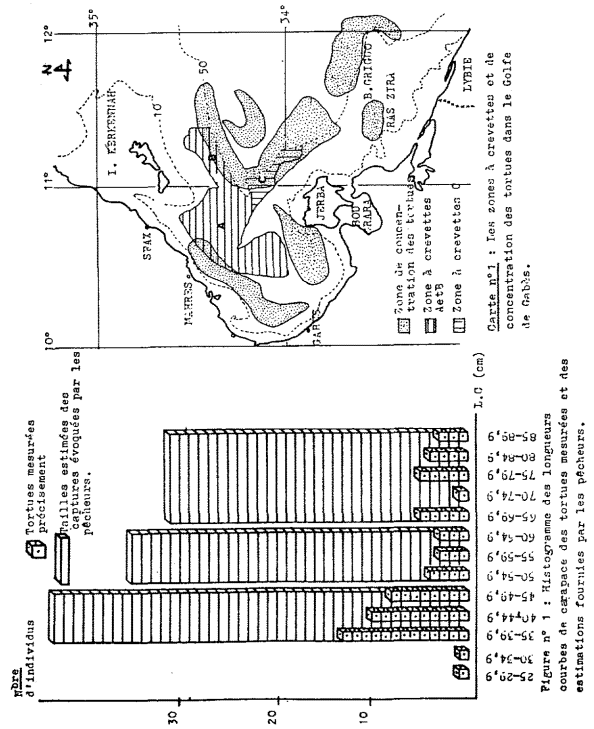
Structure démographique

61 tortues, capturées au chalut en 1990 et 1991, ont éte mesurées précisemment (fig.1); la longueur carapace courbe moyenne est de 51,32cm (écart type: 16,4). Nous avons en outre rangé les estimations pour 109 captures, fournies par des pêcheurs au chalut, enquêtés sur le sujet, dans 3 classes de taille: 35 - 50 cm, 50-65 cm et 65-90 cm (fig.1). Par ailleurs nous notons les captures suivantes (tabl. I).

Date	Lieu	L.C.C.	Métier	Observations
Sept. 1984	Kerkennah	6,3 cm	Cherfia	Conservee au laboratoire
1988	Kerkennah	10,0 cm	Cherfia	Vit en captivite
26/8/91	Gannouche	environ10cm	Tremail	Signalee par un pêcheur
28/8/91	Kerkennah	8,8 cm	Tremail	Conservee au laboratoire

Tableau 1: Captures de tortues nouvelles-nées. L.C.C.: Longueur Carapace Courbe.

La présence d'adultes, 21,31% des captures chalutières, avec un nombre important de mâles, et des tortues "nouveaux nés" est une preuve de l'existence de sites de ponte en Tunisie. Ceux qui ont été mis en évidence sont peu importants et sont situés au-delà du golfe de Gabès (LAURENT *et al.*, 1990). L'exploration des plages du sud tunisien est nécessaire.



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The Monk Seal Rescue Center of the National Park of Port-Cros (France)

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The monk seal, *Monachus monachus* (Hermann, 1779), is one of the most endangered species in the world. At present, the world population is between 200 and 300 individuals. The species is in constant decline and its disapppearance from the Mediterranean basin and the Atlantic coast may occur before the year 2000.

The causes of the decline of the monk seal are all linked to the activities of man:

- direct destruction by fishermen who consider it a competitor,
- lose of its habitat due to industrial and touristic development,
- over-exploitation of the fish on which it feeds.

To protect the monk seal, it is indispensible that:

- the species is protected by law,
- there are effectively managed protected areas with efficient legislation,
- the public are aware of its protection,
- injured or sick animals, as well as abandoned pups, are cared for (Rescue Center).

Rescue Organisation.

If an injured or sick monk seal or abandoned pup is found: telephone the following numbers:

- free phone: 93.33.49.49 (day) or 93.33.76.76 (night)
  Marineland Antibes, 24h/24h and 365 days/year.
- Environmental Agency of the country concerned.

In accordance with the Environmental Agency of the country concerned and the DG XI (Commission of the European Community, Brussels), the Rescue Center team can intervene immediately on the spot, to examine the animal and to give an initial diagnosis. If it appears that the animal can be cared for or raised in place, the Rescue Center team will commence treatment.

If it appears that the animal must be transferred to give it more intensive care, the Rescue Center, in accordance with the authorities of the country and respecting international conventions, will arrange for, and assume the financial costs of, transport of the seal. All will be done to guarantee transport in the best possible conditions in order to limit the eventual stress to the animal.

At the Rescue Center, the animal will receive all necessary care. This will be conducted under the sanitory control and supervision of permenant veterinarians. The personnel and the veterinarians who will take care of the animals have a large experience in the care of marine mammals.

The seal, once out of danger, will be repatriated to the country of origin. The precise site of the release will be determined by the authorities of the country. The cost of repatriation will be paid for by the Rescue Center.

Information Network

The Rescue Center is very interested in collaboration with all persons who are involved with seals. The Center would like to establish a network of observers acting as much as information gathers, e.g. on the distribution of the monk seal, as lookouts to warn of the presence of seals requiring the rapid assistance of the Rescue Center team.

An information network, with one or several centers in each country concerned, would enable a more efficient rescue service and would permit a better knowledge of the actual condition of the seals (through regular and systematic evaluation of the populations) and their exact distribution.

Loggerhead (*Caretta caretta*) frequency observed in the Spanish surface long-line fishery in the Western Mediterranean Sea during 1989

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The swordfish fishery with surface long lines is a very important activity for the Spanish fleet in the Mediterranean Sea. The total catch of swordfish in Spain in 1989 was of 1132 Tm with a total effort of 7.294.495 hocks. The landings in Alicante during this year were the 37.07% of the total Spanish catches in the Mediterranean. The long liners fishermen usually develope their activity throughout the whole year, increasing it during the spring and summer seasons, working in the area between Gibraltar Strait and 6ºE, although the main fishing area is located south of the Balearic Islands and the Ibiza Channel.

The analysis of the swordfihs catches suggest that more than a 50% of the total catches a year belong to 0+ and 1+ age groups (ZOUROS *et al.*, 1991). The long lines used by the spanish fleet are similar to those used in the last years, but the total catches in 1989 were 628 Tm less than the year before (ICCAT, 1991). On the basis of analysis of daily inquiry among long liner landings in Alicante during 1989, we have obtained the frecuency of accidental catches of Loggerhead in the area located between Gibraltar Strait and 6ºE Southern 41ºN. The total of long-line boats sampled were 60 units.

From the study of accidental catches of Loggerhead made upong the sampling of Alicante, we have estimated a total catch per month (grouped in subareas of 1º x 1º) for the long-line fleet in the Mediterranean. We estimated a number of 15.339 individuals, with a maximum of 5857 turtles in June a minimum of 9 in February.

There is a correlation between total effort and accidental catches of Loggerhead, but the maximum effort if in July, which is not coincident with the higher values of Loggerhead catches. The relationship between Loggerhead catches and surface temperature in this area (MILLER, 1976), shows that the maximum catches are previous to the higher temperature. The analysis of the relation between capture areas and months, allow us to establish the following single migratory schema:

- First catches take place in the area surrounding Mallorca and Ibiza Islands.
- The catches start in March in front of Alicante and Cartagena coastline increasing its abundance in the Balearic Island in the same period.
- By June the populations have disappeared form the Balearic Island. The principal concentration is extended between the Spanish coast and Algeria, within a great band.
- The biggest concentration appears in autumn in the Alboran Sea, being possible to find some small dispersed groups of Loggerhead located in the main capture areas.
- Between November and March, the population is residual in the Western Mediterranean.

Concluding

1. The Western Mediterranean Sea is apparently a nursey ground for *Caretta caretta*.
2. In summer a migration towards the east takes place, along the Argelian coastline.
3. In autum, the population is scarce around the Balearic Island, increasing in the Alboran Sea, probably showing a migration throughout the Gibraltar Strait towards the Atlantic waters.

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V

Preliminary study on the seasonal distribution of teleosteans larvae in the Aegean Sea. I. Fam. Serranidae

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At least eight species of serranids are known to occur as adults in the Aegean Sea (PAPACONSTANTINOU, 1988), of which the following six have been recorded as larvae during routine ichthyoplankton surveys carried out in the central Aegean Sea : Anthias *anthias, Callanthias ruber, Epinephelus alexandrinus, Serranus hepatus, S. cabrilla and S. scriba.* Results are presented in this study on the distribution, abundance and depth distribution of serranid larvae collected between June 1990 and February 1991 in a total of 21 stations off the Eubia coasts and the Pelion peninsula, visited at approximately bimonthly intervals.

Sampling at each station was conducted with a BONGO net, towed horizontally at a ship's speed of 2.5 knots at desired depths, and a MARK III high speed sampler, towed obliquely from near the bottom to the surface, at a ship's speed of 5 knots. The BONGO net was fitted with gauzes of 500 μ mesh aperture and the MARK III with gauzes of 250 μ. Additional sampling was carried out in a number of stations using a METHOT mid-water trawl with a cod-end mesh aperture of 2.0 mm for catching late larvae and post-metamorphosed fish. In the laboratory the eggs and larvae of all fish species were extracted from the samples, identified to the lowest possible taxon, counted and measured. Numbers per haul were converted to numbers per 1000 m³ of sea water using the flowmeter readings. Table I shows the seasonal and vertical distribution of the serranid larvae, respectively, using the BONGO net data series. It appears that with the exception of *C. ruber*, all other species seem to be summer or late summer spawners. The data suggest that *S. hepatus, S. cabrilla* and *S. scriba* inhabit the upper water layer, while *A. anthias* and *C. ruber* were also found in deeper layers.

Table 1 - Seasonal and vertical distribution of serranid larvae (larvae por 1000 m³ sea water), using the Bongo net data series.

Species	Month					Depth		
	June	July	September	December	February	0-50	51-100	101-205
A. anthias	-	-	2.3	-	-	1.1	0.6	4.2
C. ruber	4.6	1.9	1.7	6.4	3.3	1.7	3.3	5.1
E. alexandrinus	-	-	1.1	-	-	1.1	0.6	-
S. cabrilla	13.9	1.9	12.0	-	-	18.4	10.0	-
S. hepatus	60.3	145.8	620.3	-	-	388.4	463.0	92.1
S. scriba	-	-	8.0	-	-	11.5	2.2	-

The MARK III net caught significantly fewer larvae (in total, 1111 larvae over the surveyed period, of which 59 belonged to serranids) in comparison to the BONGO net (17720 larvae of which 1283 belonged to serranids), due to the much lower volumes of water filtered and shorter hauling times of the first instrument. However, the MARK III sampled more efficiently the water column, due to its finer meshes, and gave a higher average concentration of eggs and larvae than the BONGO net (Table 2). The METHOT trawl caught relatively fewer larvae and an insignificant number of eggs, as expected, due to its coarse meshes. The most complete coverage of the sampling area with this instrument occurred in September 1990, and yielded 813 larvae (out of which 170 belonged to serranids, almost exclusively *S. hepatus*). *S. hepatus* was the most abundant species, followed by *S. cabrilla*. About 95% of the total collected larvae belonged to *S. hepatus*, of which 89.3% were fished in September. Fig. 1 shows the horizontal distribution of *S. hepatus*, using the MARK III data series. The apparent length distribution of *S. hepatus* larvae caught with the three sampling instruments used is shown in Fig. 2.

The length distribution of *S. hepatus* larvae caught in different sampling periods were compared, and no significant differences were found. These results indicate that breeding is continuous, beginning probably in May, and is completed in late September, with a peak spawning in late August, which is in accordance with the results of a study of the gonadal maturation cycle of this species in the Aegean Sea (PAPACONSTANTINOU, unpublished data). However, differences in the length distribution of *S. hepatus* larvae caught in inshore and offshore stations were found, suggesting a gradual dispersal from spawning sites occurring in shallower waters to deeper ones.

Two spawning subareas in of *S. hepatus* were found in the sampling area : one at the north of the Skiathos channel, which is influenced by the N. Aegean Sea hydrographic system, and the other at the Trikeri channel. The highest densities were found in the second area, which is influenced by the Evoikos gulf hydrographic system and is characterised by a broad continental shelf.

Table 2.- Absolute and average number per 100 m³ filtered water over the surveyed areas sampling period with BONGO net and MARK III.

		BONGO net		MARK III	
		Number	Number/100 m³	Number	Number/100 m³
June	Eggs	5779	1633	373	2552
	Larvae	1509	375	211	1045
	Serranid larvae	68	18	9	50
July	Eggs	2361	896	232	2677
	Larvae	605	202	185	1883
	Serranid larvae	80	32	10	102
September	Eggs	2345	530	132	1921
	Larvae	11615	2522	595	5719
	Serranid larvae	1129	236	40	401

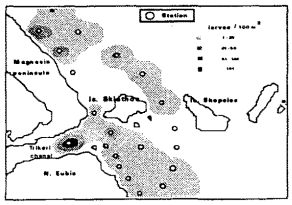

Fig. 1

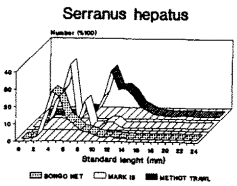

Fig. 2

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The Stripped dolphin disease in Greece, 1990-1992

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The Stripped dolphin (*Stenella coeruleoalba*) is a cosmopolitan cetacean with a wide distribution range from tropical to temperate areas. It was considered until now as the most abundant dolphin in the Mediterranean (BOMPAR *et al.*, 1991). From the summer 1990 its situation has drastically changed. The species has been affected by an epizootic which has depleted its population in the Western basin and is actually striking it in the Eastern basin. The epizootic is caused by a morbillivirus named dolphin morbillivirus (DMV) (OSTERHAUS *et al.*, 1992).

Evolution of the mortality in Greece

First data available on stripped dolphins stranded in Greek waters are from Zakynthos and correspond to July 1991. Twelve dead dolphins had been found in this island up to February 1992. Several samples were sent in August to the Bilthoven laboratories (Holland) by the W.W.F. team working in Zakynthos on Monk seals (*Monachus monachus*). Some of the dolphins had been affected by dolphin morbillivirus with certainty, confirming the presence of the epizootic in Greece (VLACHOUTSIKOU, pers com).

No figure is known about the natural stranding of cetaceans before the epizootic, but a geographical progression of the strandings towards the East and North East of the country have been observed. The number of dead animals was still increasing in February and it was not known if a maximum had been already reached (fig. 1). A total of 83 cetaceans had been recorder up to 6 Februàry 1992, from the beginning of the disease; 54 of them are Stripped dolphins and 16 are unknown dolphin species.

Special consideration must be given to the species found dead during this period. Although most of the individuals are Stripped dolphins, it is also significant that 5 Cuvier's beaked whales *Ziphius cavirostris* were present (see fig. 2), four of them stranded in a period and location with many records of *Stenella coeruleoalba* deaths. This toothed whale inhabits very deep waters, and their strandings are usually scarce because they live far away from the coasts. It is not known if the morbilliviruses have also affected this species or any other of the ones shown in fig. 2, but it can not be considered impossible. KENNEDY *et al.*, (1988) recorded morbillivirus infection in common porpoises (*Phocoena phocoena*) from Northern Ireland. Also OSTERHAUS *et al.*, (1992) found morbillivirus in two common porpoises stranded in Holland and named it porpoise morbillivirus (PMV). The epizootic which affect the Stripped dolphins is produced by DMV (OSTERHAUS *et al.*, 1992). The character teuthophage of both Stripped dolphins and Couvier's beaked whales could have facilitated the physical proximity between individuals of these species and a consequent infection.

In addition, OSTERHAUS *et al.*, (1992) proved that Bottlenose dolphins (*Tursiops truncatus*) blood cells can be infected by dolphin morbillivirus in laboratory. Three individuals of this species have been stranded in the research period, all of them in areas known to be infected, but their vulnerability in the wild has not been demonstrated.

Origin of the epizootic

It has been hypothesized (BOMPAR *et al.*, 1991) that Phocine distemper virus (PDV) could have been transported by the Atlantic population of stripped dolphins to the Mediterranean, without been affected by the virus because of natural inmunization. The stranding of Stripped dolphins also in the Spanish Atlantic could be against this argument. The same authors consider remote the possibility of infection by seals.

Nevertheless, two ill Hooded seals (*Cystophora cristata*) arrived at the coasts of southern Spain in June 1990, one at Huelva and the other at Tarifa (personal data). Both animals died within a few hours, the latter at least with symptoms of canine distemper virus (CDV), a disease very similar to PDV. The presence of three dead seals in the north of Morocco was also reported at this date. No data exists to confirm that these individuals were Monk seals (*Monachus monachus*) and not Hooded seals. An incursion of infected Hooded seals in the Mediterranean could explain the origin of the epizootic in Valencian waters about one month later. A similar incursion by Harp seals (*Pagophilus groenlandicus*) to the North Sea caused the mass mortality of Harbour seals (*Phoca vitulina*) and Grey seals (*Halichoerus grypus*) in 1988 (BOMPAR *et al.*, 1991).

Very recent data (OSTERHAUS *et al.*, 1992) confirmed the presence of morbillivirus antigen and nucleic acids in the Hooded seals from Spain.

On the other hand, the same authors demonstrated that the DMV is closely related to PMV and different from PDV-1 and PDV-2 and concluded that different clusters of morbilliviruses were responsible for the cetaceans.

Fig. 1.- Stranded cetaceans in Greece 1990-1992.

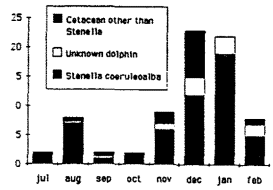
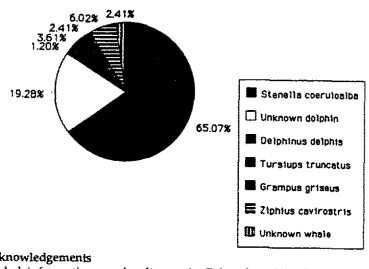


Fig. 2.- Cetacean species stranded in Greece from July 1991 to February 192 (N=83).



Acknowledgements

Ada VLACHOUTSIKOU, (WWF-Greece) provided information on the disease in Zakynthos; Keti Siakavara, (Greenpeace-Greece) did the same at Crete. The National Centre for Marine Research coordinated the data collection.

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Distribution of Cetaceans in Greece, 1990-1992

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Information regarding the distribution of marine mammals in Greece still remains scarce because no long term studies have been undertaken in the region until now. Detailed information on the subject is only available for the Mediterranean Monk seal (RONALD and DUGUY 1978; CEBRIAN and VLACHOUTSIKOU 1991).

Preliminary data on the distribution of cetaceans in Greece are presented.

Methods

Data were obtained by means of direct observation and also with the aid of an identification file sent to the Port Police and to environmental groups involved with the Sea. The files are a Greek translation of the one used for the C.I.E.S.M. International Programme for the Registration of Cetaceans in the Mediterranean, and were collected by the N.C.M.R. (National Centre for Marine Research).

Results

The following 11 species have been recorded during the research period in Greek Waters:

Stenella coeruleoalba, Delphinus delphis, Tursiops truncatus, Ziphius cavirostris, Mesoplodon densirostris, Globicephala melaena, Grampus griseus, Orcinus orca, Physeter catodon, Balaenoptera physalus and *Delphinapterus leucas*.

The information available gives the following distribution patterns:

Stenella coeruleoalba

Present in all the Ionian Sea, Saronikos Gulf, Mirton Sea, Evia, Gulf, Dodekanisos, Krete, Rodos. East Aegean and Chalkidiki. The species is registered in waters shallower than 200 m.

Delphinus delphis

Also present in the Ionian Sea. Mesolonghi lagoon. Southern Peloponissos, Krete, Karpathos, Rodos. Southern Evia, Central Cyclades, Lesbos, Chios, Northern Aegean. Also inhabits waters shallower than 200 m.

Tursiops truncatus

The scarce data available locate them in Southern Peloponissos, Krete. Karpathos. Northern Cyclades, Southern Evia, Chalkidiki and Thermaikos Gulf.

Ziphius cavirostris

Four individuals stranded in Rodos, one in Alonissos, one doubtfull in Krete and one doubtfull in Karpathos.

Mesoplodon densirostris

One dead individual floating offshore Mani. Southern Peloponissos (POULOPOULOS pers com). Only another record of the species exists in the Mediterranean, a female stranded South of Barcelona (DUGUY *et al.*, 1983).

Globicephala melaena

Recorded offshore Antikithira and at the tips of Chalkidiki. Seems to be scarce.

Grampus griseus

Observed in Othoni (NW from Kerkira), offshore Western Crete, also in Southern Evia, Karpathos. and South from Chalkidiki. Its presence was considered before as limited to the Western Basin (DUGUY *et al.*, 1983).

Orcinus orca

Only one record from Southwestern Peloponissos.

Physeter catodon

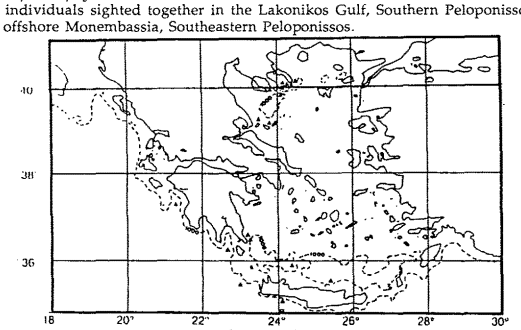
Associated with deep waters, more than 1000 m depth (fig. 1). Present along the canyons North and South from Krete, and South from Chalkidiki. Also recorded in Southern and Western Peloponissos and at the North face of Sporades Islands. Possible harems sighted in Southern Chalkidiki and Western Peloponisos.

Delphinapterus leucas

Exceptional record of this Artic species in the Southern Black Sea. The individual evidently passed across the Aegean Sea.

Balaenoptera physalus

Two individuals sighted together in the Lakonikos Gulf, Southern Peloponissos. Another record offshore Monembassia, Southeastern Peloponissos.



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Fréquence des Espèces de la famille des Centracanthidae lors de captures effectuées à l'aide d'engins de pêche côtière le long de l'Adriatique Orientale, en période hivernale

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L'ichthyofaune adriatique comprend 4 espèces de la famille de Centracanthidae : picarel (*Spicara smaris*), gerle (*Spicara flexuosa*), mendole (*Spicara maena*) et picarel guetteur (*Centracanthus cirrus*). Tandis que cette dernière espèce se trouve assez rarement en Adriatique du Sud, les autres espèces se trouvent très souvent sur tout le littoral de l'Adriatique Orientale.

Spicara smaris demeure sur les fonds sableux - fangeux couverts de Posidonia, à une profondeur de 10 à 100 m. En hiver, ce poisson reste dans des eaux moins profondes qu'en été. *Spicara flexuosa* réside sur les fonds sableux - boueux sans végétation, à une profondeur de 30 à 130 m. Cette espèce, reste aussi durant la période hivernale dans des eaux moins profondes qu'en période estivale. Quant à *Spicara maena*, elle préfère les fonds rocheux, jusqu'à une profondeur de 100 m, en demeurant en hiver dans des eaux plus profondes qu'en été.

La pêche côtière effectuée le long de l'Adriatique Orientale jusqu'à la profondeur de 60 (80) m comprend de nombreux types d'engins (utilisés à cette profondeur).

La distribution verticale, les migrations saisonnières et les intervalles de ponte des espèces de Centracanthidae en Adriatique sont les facteurs essentiels qui limitent les captures de ces poissons à l'aide des engins de pêche côtière et qui règlent leur existence.

Dans ce travail, ont été analysées les captures de 3 types de chalut de fond côtier à panneaux destinés uniquement aux captures de Centracanthidae (surtout de *Spicara smaris*). Ce sont "strasin", "kogol", "tartana" et également un type de senne côtière, nommée "migavica". Ces captures ont été réalisées pendant les mois frais (octobre - avril) de 1986 à 1992 le long des côtes de l'Adriatique Orientale moyenne et du Nord (île de Losinj - Makarska). On a employé des engins de pêche côtière à diverses profondeurs, "strasin" de 5 à 20 m, "kogol"de 5 à 20 m, "migavica" de 0 à 30 m, "tartana" de 20 à 50 m.

L'utilisation de ces engins de pêche le long de côtes orientales de l'Adriatique est autorisée seulement en période hivernale, afin de protéger les espèces de Centracathidae dont la période de frai se situe en été.

ZUPANOVIC (1956), MOROVIC (1962 et 1963), CETINIC et PALLAORO (1990a et 1990b) ont déjà étudié le même thème.

La Figure 1. présente le facteur de poids (exprimé en pourcentage) des espèces de Centracanthidae capturées au moyen d'engins de pêche examinés après un coup de filet. Le Tableau 1. présente le même facteur selon les mois des captures.

Tableau 1. Captures des espèces de la famille Centracathidae à l'aide d'engins de pêche côtière selon les mois d'activité.

Engins	Mois	10 %	11 %	12 %	01 %	02 %	03 %	04 %
"strasin"	*Spicara smaris*	25.4	20.7					
	Spicara maena	0.6	47.4					
"kogol"	*Spicara smaris*	45.5	34.0	26.4			30.1	
	Spicara maena	9.0	4.5	7.2			16.3	
	Spicara flexuosa	-	-	0.1			-	
"migavica"	*Spicara smaris*				40.9	44.2	11.5	26.4
	Spicara maena				0.5	14.0	15.7	16.7
	Spicara flexuosa				0.2	-	-	-
"tartana"	*Spicara smaris*				23.5	46.4	25.8	59.2
	Spicara maena				-	-	6.5	-
	Spicara flexuosa				41.0	22.2	0.3	3.0

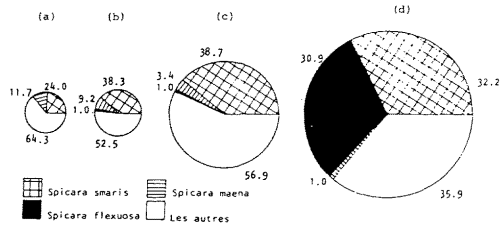

Fig. 1. Fréquence de poids (en pourcentage) des espèces de Centracanthidae à l'aide des engins : (a) strasin, (b) kogol, (c) migavica, (d) tartana - après un coup de filet.

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V

Croissance du Mérou *Epinephelus guaza* L. des Côtes de l'Ouest Algérien

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La présence du mérou *Epinephelus guaza* est assez rare dans les pêcheries de l'ouest algérien depuis une dizaine d'années. Cette espèce est surtout capturable par la pêche sportive, palangre de fond, lignes mortes et chasse sous-marine. Cette étude porte sur un échantillon prélevé dans une zone géographique qui s'étend de Ghazaouet (1° 51' LW, 35° 5' lN) et l'Ile Ronde (1° 33' LW, 35° 17' lN).

Parmi les différentes méthodes de détermination directe de l'âge testées, scalimétrie, otolimétrie, utilisation des coupes transversales des rayons épineux de la nageoire dorsale fixés dans de la résine promodentaire, seule la première a fourni des observations exploitables.

Les mensurations rétro-calculées par la méthode de LEE (1920, in CHALI-CHABANE, 1988) ont servi à la modélisation de la croissance linéique et pondérale selon le modèle de Von Bertalanffy. La croissance relative a été abordée en établissant la relation entre la longueur totales LT et le poids total WT selon la relation de TEISSIER (1948) de forme $WT = a.\ LT^b$.

Sur les 60 individus capturés en chasse sous-marine, 39 ont été retenus pour la scalimétrie. Les longueurs rétro-calculées jusqu'à l'âge 8 sont représentées dans le tableau suivant :

Age (années)	1	2	3	4	5	6	7	8
	26.92	36.21	44.37	57.11	66.53	73.11	81.55	86.85

Les équations de croissance obtenues pour *E. guaza* sont :

- croissance linéique : $L_t = 177.43\ (1 - e^{-0.073(T+1.24)})$
- croissance pondérale : $W_t = 116.81(1 - e^{-0.073(T+1.24)})^{2.971}$

(b = 2.971 n'est pas significativement différent de b = 3, pour un risque de 5%.)

- croissance allométrique : $WT = 2.43.10^{-5}.LT^{2.971}$

* W est exprimé en kg et L en cm.

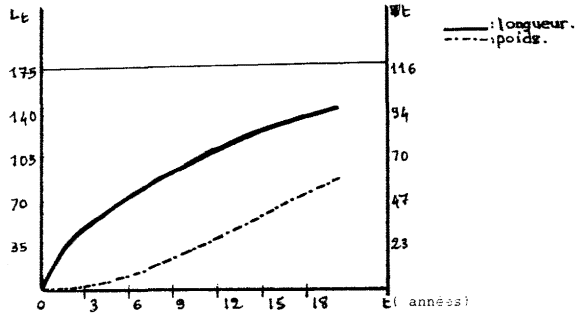

Figure représentant les courbes de croissance théorique linéique et pondérale du mérou *E. guaza*

La modélisation de la croissance selon le modèle de VON BERTALANFFY représenté sur la figure indique une croissance duquel l'augmentation pondérale se ralentit, rapproche la courbe de la valeur asymptotique, le taux de croissance devenant négligeable. Il ne s'agit cependant que d'une extrapolation des observations réelles limitées à l'âge de 13 ans.

Les longueurs et poids asymptotiques calculés sont nettement supérieurs aux valeurs maximales mentionnées lors des records de capture, de l'ordre de 60 kg.

Les valeurs enregistrées indiquent néanmoins une discontinuité dans la courbe de croissance. L'application dans tel cas d'un modèle composite en deux stances (GASCUEL *et al.*, 1991) pourrait éventuellement mieux décrire les mécanismes d'évolution du mérou. Ce poisson hermaphrodite protérogyne (CHAUVET, 1988) subit des transformations physiologiques lors de l'inversion sexuelle, influant obligatoirement sur la croissance.

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Détermination de l'âge de l'espadon *Xiphias gladius* à partir de l'observation du second rayon épineux de la nageoire anale

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L'âge de l'espadon a été estimé à partir de diverses pièces osseuses, otolithes (RADTKE et HURLEY, 1983), rayon épineux de la nageoire dorsale "REND" (ARTUZ, 1963), rayon épineux de la nageoire anale "RENA" (BERKELEY et HOUDE, 1983). Un essai tenté sur le REND (CHALABI *et al.*, 1990) s'est avéré d'interprétation délicate, la clé âge-longueur obtenue ne répondait pas au principe de la dégressivité du taux d'accroissement annuel. L'étude, reprise en utilisant cette fois-ci le RENA, a d'ailleurs retenu l'attention de divers auteurs (TSIMENIDES et TSERPES, 1989).

La nageoire anale, unique chez le jeune espadon, est présente en deux parties chez l'adulte ; elle suit la même évolution que la dorsale. Le premier rayon de l'anale étant petit, voire indistinct chez les petits individus, c'est le second qui est utilisé pour la lecture. Après nettoyage, le RENA est coulé dans un bloc de résine promo-dentaire puis découpé transversalement en lamelle d'un millimètre d'épaisseur environ (cf. fig.).

Deux problèmes fondamentaux se sont posés. Le premier d'ordre technique, concernait l'utilisation de matériel spécifique indisponible et équipant généralement les laboratoires de géologie. Un atelier a été monté avec du petit matériel ; les coupes ont été réalisées grossièrement à l'aide d'une scie de bijoutier puis affinées progressivement à la meule électrique. Cette solution présentait l'avantage de minimiser les frais de coupes auparavant confiées à des difficultés. En effet, le RENA étant cônique, le plan de coupe devait obligatoirement s'effectuer à une distance proportionnelle à la croissance de la pièce de manière à pouvoir procéder à un rétro-calcul ultérieur ; or les prestations proposées ne pouvaient inclure de telles contraintes. La possibilité de procéder aux coupes au laboratoire a permis de les réaliser selon un rapport diamètre de la base/diamètre de la coupe constant à + ou - 0.31.

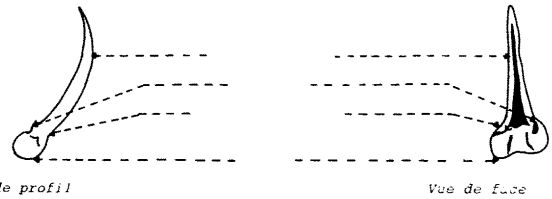

Schéma d'un RENA. Mesure des diamètres de coupe

Les observations sous loupe binoculaire ont porté sur 99 RENA, avec un taux de détermination de l'ordre de 98%. L'épaisseur des bandes opaques plus importante que celle des hyalines (JOHN et JOLLEY, 1977) n'est pas systématique. L'ensemble des individus étudiés, mesurant entre 65 et 172 cm de longueur sans rostre (LFJL) avait trois ans au maximun.

Cette structure démographique du stock exploité, caractérisée par l'absence de vieux individus, correspond aux observations notées précédemment (CHALABI *et al.*, non publié). Les engins utilisés, palangres dérivantes de surface ou chaluts pélagiques capturent les spécimens situés dans les 100 premiers mètres de profondeur ; il semblerait que les espadons plus grands soient plus profonds et donc inaccessibles aux méthodes de pêche artisanale.

Du point de vue technique, la méthode utilisée, de par sa simplicité et sa qualité d'observation, présente un intérêt certain, d'autant plus que les coupes des individus âgés, plus difficilement interpétables, peuvent faire l'objet d'amincissement jusqu'à l'obtention de l'épaisseur idéale.

La qualité de l'observation dépend aussi du traitement préalable de la pièce. Les meilleurs résultats ont été obtenus en séchant immédiatement au soleil quand il fait chaud ou à l'étuve en hiver, les RENA dès leur prélèvement. Cette pratique empêche le stroma du rayon de s'étaler et masquer les premières bandes, ce que la réfrigération ou la congélation ne permet pas d'obtenir.

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V

Batch fecundity of the Mediterranean pilchard (*Sardina pilchardus sardina* Risso) on the Turkish Coasts of the Aegean Sea

Bulent CIHANGIR

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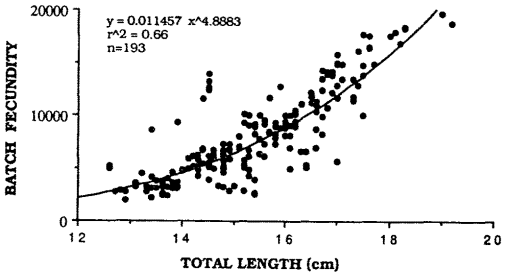
Pilchard's (*S. Pilchardus pilchardus*) batch fecundity was determined for the first time in the Atlantic, Iberian Peninsula by PEREZ *et al.* (1989). In this study, the Mediterranean pilchard's *S. pilchardus sardina*) batch fecundity is presented.

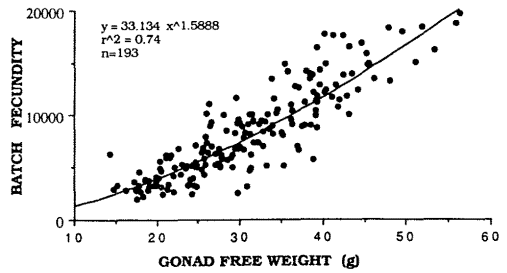
Pilchard (*Sardina pilchardus*) is a serial spawner with protracted spawning seasons and a high number of spawnings per year (BLAXTER & HUNTER, 1982).

The Mediterranean pilchard's reproduction process on the Turkish Coasts of the Aegean Sea takes place between the months of September to May. According to the sexual maturation index (Gonadosomatik Index), the maximum reproduction period occurs during the months of December, January and February in which sea water temperatures reach to annual minimum (CIHANGIR, 1991).

Ovary of 193 female pilchard in hydrated and advanced condition were collected on the Turkish Aegean Coasts by purse-seiner fishing boats during the peak of the spawning months in 1989-1990.

Fish preserved in a 4% buffered formaldehyde solution (HUNTER, 1985), were analysed in the laboratory for fecundity determination. Hydrated and Oocyte Size-Frequency methods were applied on pilchard ovaries. Ovaries were examined for presence of post ovulatory follicles. Ovaries which contain post ovulatory follicles were not used for batch fecundity estimations due to some oocytes being already released. The method is described in HUNTER *et al.* (1985).





In this study, batch fecundity is found to be 2000-3000 eggs/female for the lengths of 12-13 cm and 10000-15000 eggs/female for the lengths of 16-17 cm. The highest batch fecundity is 20000 eggs/female in 19.1 cm indivudial. Batch fecundity, the number of eggs released per spawning event, of pilchard increases with fish size. The relationship of batch fecundity and total length, ovary free weight are shown in the figures.

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V

Preliminary note on the pattern of otolith rings formation in juveniles of *Merluccius merluccius* L. in the Northern Tyrrhenian Sea

Viva CLAUDIO* and Franco BIAGI**

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This work is part of a wide research project aimed to clarify the growth pattern of Mediterranean hake, *Merluccius merluccius* L. Identification of the first winter annual ring is a primary goal to understand the pattern of otolith rings formation. Examined otoliths came from fishes collected both by sampling of commercial landings and by trawl surveys carried out in the Northern Tyrrhenian Sea from October 1990 to September 1991. Otolith rings were measured along their longitudinal axis through a micrometric binocular according to a methodology suggested by ALDEBERT Y., MORALES-NIN B. and OLIVER P. in the frame of the EEC research project MA-1-232 (pers. comm.). Fish length composition of the sample was restricted to fish smaller than 21. 0 cm in total length (T.L.) to ensure the coverage of all rings formed during the first year of life. Two specimens were sampled for each 1 cm size class in T. L. every month. Here we deal with one aspect only of the problem that is in a sample of otolith rings those formed periodically rather than occasionally will appear more often. Moreover a consistent measurement of the length of all rings on every otolith of a sample will produce a frequency distribution of length at which rings occur in the studied sample.

Fig. 1 shows the average number of visible rings measured in each otolith by 3 cm size class of T.L. It is evident that the number of false rings change in accordance with T.L., at least in the first 20.0 cm of fish T.L.; an overall average number of 4 false rings has been found and we can have up to 9 rings in the last size class of 18.0 cm. These findings are similar to those reported by GONI (1983) and GONI and PINEIRO (1988).

The overall frequency distribution of rings length by 0.32 mm size class is shown in Fig. 2. This distribution exhibits several modes that need a further analysis in order to be explained. Splitting of this polymodal distribution through Batthacharya's method is currently in progress.

Fig. 1: average number of rings by 3 cm T.L. size class

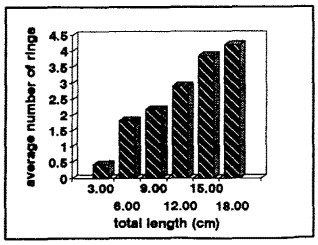
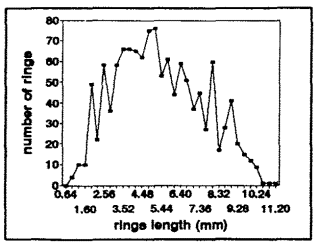


Fig. 2: frequency distribution of otolith rings measurements



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Biometric Data and weight-lenght relationship of *Nezumia sclerorhynchus* (Valenciennes, 1838) (Pisces; Macrouridae) in the Northern Tyrrhenian Sea

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Nezumia sclerorhynchus is a characteristic species of bathyal bottoms from 350 metres of depth in the Northern Tyrrhenian Sea (Western Mediterranean) between Giglio and Montecristo Isles (SARTOR *et al.*, 1990; 1991). Until now biology of this species has been studied little in the Mediterranean Sea except some aspects concerning feeding (GEISTDOERFER, 1975; 1978) and growth (RANNOU, 1976).

This paper presents both information about the relationship between some morphometric measures and the weight-length relationship of 213 specimens of *Nezumia sclerorhynchus* collected during three trawl surveys (April 91, July 91 and October 91) on a bottom ranging from 380 to 600 metres of depth. The organisms were fixed in 5% seawaterformalin for a period of about 30 days.

On every specimen the following remarks were made: total weight (approximated to 0.1 gram); total length (T.L.) of 78 specimens, only those with the whole caudal zone; opercular length (O.L.) from the tip of the snout to the opercular margin (BAS, 1963). The linear measures were approximated to the lowest millimetre below.

T.L. and O.L. (fig. 1) were highly correlated (r=0.987571) and the linear regression parameters (a=9.3408; b=6.1216) were calculated with model I of regression that explains a variance of 96.53%.

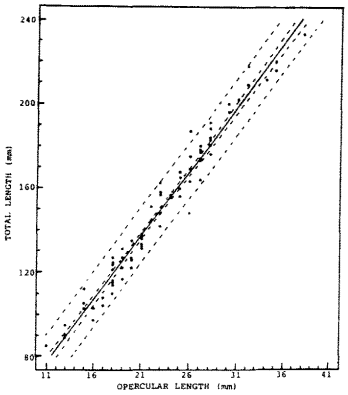


Fig. 1

The equation of regression (T.L.=9.3408+6.1216*O.L.) enable us to calculate T.L. of all collected specimens and to reconstruct the size composition of the sampled population (fig. 2) (range T.L.: 70.56-248.08 mm).

The weight-length relation-ship (fig.3) was calculated by a linear regression (model I) applied to the multiplicative model y=aX^b. It has turned out a positive allometric relation (weight=3.4*10^-8* T.L.^3.78913) with high corre-lation coefficient (r=0.989356) and an explained variance of 97.88%.

Fig. 2

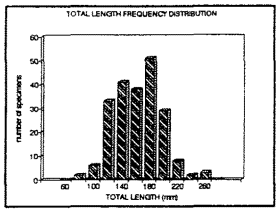
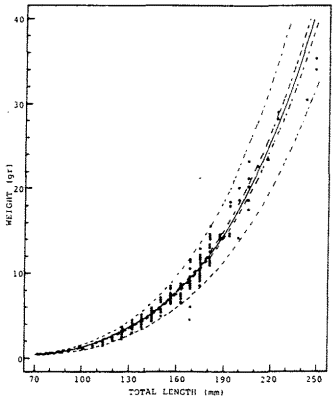


Fig. 3



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Relationship between total length vs. otolith length in *Mullus barbatus* L. and *Trisopterus minutus capelanus* (Lacepède) in the Northern Tyrrhenian Sea

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Relationships between the current body length of a fish and the sizes of one or more marks in some hard part of its body are widely used in fishery biology. For example back-calculation method enable fishery researchers to obtain growth parameters estimates that, in addition, could be used to validate results coming from direct reading of otoliths. Moreover computation of the relationship between fish total length (T.L.) and otolith size is very useful in trophic ecology studies, where otoliths are often the only recognizible fish structure in the stomach content of many predators.

This work deals with the relationship between fish T.L. vs. otolith length in two very common fish species in the Northern Tyrrhenian Sea (DE RANIERI *et al.*, 1988; BIAGI *et al.*, 1990, 1992): *Mullus barbatus* and *Trisopterus minutus capelanus*. The specimens were collected by otter trawl in the area between Elba and Giannutri Islands during October 1991. Five otoliths (Sagitta) were sampled for each 1 cm size class of fish T.L. The sagittae were cleaned and preserved in 50% alcool after extraction. Otolith length was measured by micrometric binocular and it was approximated to the nearest 0.16mm.

Analysis of the scatterplots suggest a linear relationship in both species. The parameters were estimated by model I of linear regression (SOKAL & ROHLF, 1981; FRANCIS, 1990) and the relationships are shown in Fig. 1 and Fig. 2 for M. *barbatus* and T. *minutus capelanus* respectively.

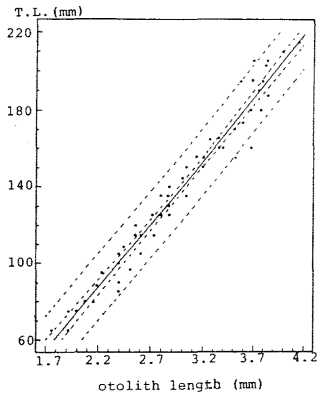

Fig. 1: M. barbatus

n° = 60
y = -56.68 + 65.48 * x
r = 0.9818.

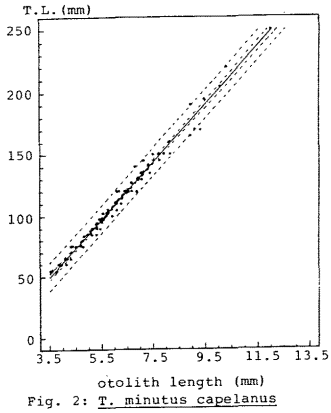

Fig. 2: T. minutus capelanus

n° = 70
y = -31.78 + 23.29 * x
r = 0.9913.

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V

Proposition d'un unité d'effort de pêche pour la Pêcherie Chalutière Algérienne

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Introduction.

Dans un souci d'uniformisation de la collecte de l'effort de pêche et afin de proposer une unité d'effort reflétant au mieux l'exploitation de la flottille chalutière algérienne, des études, étalées sur trois ans, ont été entreprises sur un ensemble de pêcheries représentatives en nombre de l'exploitation chalutière nationale. Le choix des ports de pêche a été fait sur la base de l'importance des flottilles de pêche et de leurs débarquements ainsi que de leurs localisations géographiques, afin de couvrir l'intégralité du littoral. D'Ouest en Est l'étude a porté sur les ports de pêche de Ghazaouet, Béni-Saf, Bou-Aroun, Alger, Béjaia, Annaba et El-Kala.

Matériel et méthode.

Partant du principe que la meilleure unité d'effort est celle qui, appliquée à un navire quelconque de la flottille, donne une prise par unité d'effort (U) la plus voisine possible de la prise par unité d'effort moyenne (U) de tous les navires de la flottille (POINSARD et LE GUEN, 1960 in LE GUEN, 1972) il a été relevé pour chacun des navires appartenant aux flottilles étudiées, la prise par unité d'effort (Ui) en employant différents types d'unité d'effort, ce qui a servi à calculer la prise moyenne par unité d'effort de chaque flottille par type d'unité.

A chaque navire et pour chaque unité, on a fait alors correspondre une valeur de l'écart à la moyenne : $X = |Ui - U|$. A partir de ce calcul on peut considérer que la meilleure unité d'effort est celle pour laquelle la valeur moyenne des écarts (X) est la plus faible.

De façon individuelle ou associée, deux grands groupes d'unités d'effort ont fait l'objet de ce test. Il s'agit:

* des caractéristiques techniques propres aux navires: longueur, puissance, tonnage;

* du temps alloué à la pêche: jours de mer ou de pêche, temps de pêche effectif.

Résultats et discussion.

Des résultats d'écarts moyens obtenus pour la pêcherie chalutière algérienne par type d'unité d'effort testée (cf. Tableau), il ressort qu'il n'y a pas de différence notable entre l'utilisation du jour de mer ou du jour de pêche. Ceci est dû au fait qu'il est rare qu'un chalutier rentre au port sans production, aussi minime soit-elle.

En théorie, la meilleure unité d'effort serait le **jour de pêche * puissance * longueur** car c'est celle qui fournit la plus faible valeur de X.

Cependant, en pratique, l'unité **jour de pêche * puissance** nous semble acceptable pour l'étude de la pêcherie. En effet, c'est celle dont la collecte est la plus facile à réaliser et la valeur de son écart à la moyenne semble raisonnablement acceptable si on la compare à celle des autres unités testées lors de notre analyse.

Unités d'effort testées	Valeurs de $\overline{X}$
Jour de pêche * puissance * longueur	0.0380
Temps de pêche * puissance * longueur	0.0700
Temps de pêche * puissance	0.1450
JOUR DE PECHE * PUISSANCE	**0.5390**
Jour de mer * puissance	0.8230
Puissance * longueur	1.3800
Temps de pêche * longueur	1.4890
Jour de pêche * tonnage	6.4370
Jour de mer * tonnage	6.8040
Jour de pêche * longueur	10.3540
Jour de mer * longueur	16.7400
Puissance	23.4200
Temps de pêche	55.9450
Jour de pêche	198.0370
Jour de mer	223.3930
Longueur	429.6390

tableau des écarts moyens obtenus par unité d'effort testée

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Croissance de la sardine (*Sardina pilchardus*) de la région d'Alger

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Les écailles de 308 individus dont la taille variait de 10 à 19.5 cm ont été prélevées (FAO, 1957) et montées dans de l'albumine glycérinée entre lame et lamelle, après nettoyage préalable tel que recommandé par le CGPM (1981). Celles-ci ont servi à l'établissement de clés âge-longueur par sexe pour la sardine de la région d'Alger.

1. Formation de l'anneau hivernal

A partir de 167 individus répartis sur l'année, le suivi de l'allongement marginal M (CHAVET, 1986) a permis de fixer au mois d'avril la période de formation de l'anneau hivernal. Celui-ci n'est donc visible que sur les individus pêchés à partir de ce mois, au moment de la reprise de croissance, mais il faut cependant souligner qu'il s'est réellement formé quelques mois plus tôt, en hiver, au moment du ralentissement de croissance.

2. Clés âge-longueur des sardines de la région d'Alger

La date de naissance a été fixée au 1er janvier (COPACE, 1978) et les anneaux de ralentissement dénombrés pour 162 femelles et 145 mâles. Les écailles trop claires ont été éliminées et seuls les anneaux vrais et non dédoublés ont été comptabilisés. Par ailleurs chez les individus âgés, il est difficile de bien apprécier la disposition des anneaux d'hiver à la périphérie de l'écaille. La détermination de l'âge est entachée d'une erreur systématique de plus ou moins trois mois puisqu'il n'a pas été tenu compte des sardine issues de ponte précope (automale) ou de ponte tardive (printanière) (FAGE, 1913 ; DE BUEN, 1937 ; MUZINIC, 1952 ; GUERAUL, 1980).

Résultats

Sur le tableau 1 sont récapitulés les valeurs obtenues respectivement pour les mâles et les femelles, pour qui les individus âges de 8 ans sont très rares, ces dernières semblant toutefois avoir une longévité plus grande puisqu'il a été observé des spécimens âgés de 9 ans.

	Longueurs moyennes (cm)	
Age (ans)	Mâles	Femelles
1	10.56	11.05
2	12.88	12.67
3	14.11	14.66
4	15.12	16.10
5	16.09	17.00
6	16.75	17.70
7	17.35	18.15
8	17.58	18.62
9	-	19.12

Tableau 1: Clé âge-longueur des sardines mâles et femelles de la région d'Alger

3. Paramètres de croissance

A l'aide de la méthode de TOMLINSON-ABRAMSON (1961) les paramètres de l'équation de VON BERTALANFFY (1938) qui décrivent la croissance de la sardine d'Alger ont été déterminés et sont récapitulés dans le tableau 2.

Sexe	Loo(cm)	K	To(années)	Effectif
Femelle	20.28	0.256	-2.009	134
Mâle	18.73	0.282	-1.986	115

Tableau 2 : Paramètres de croissance des sardines mâles et femelles de la région d'Alger.

4. Discussion et conclusion

Les sardines de la région d'Alger ont une croissance en taille comparable à celle d'autres régions méditerranéennes, Golfe du Lion (BOULVA, 1975), Espagne (LOPEZ, 1963), Tunisie (KARTAS, 1981), Maroc (BIAZ et RAMI, 1978).

Il est apparu au cours de cette étude qu'aucun individu n'excédait la taille de 20 cm pour les femelles et de 18.5 cm pour les mâles, ceux-ci ayant une longévité moins importante que les précédentes.

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V

Foods and feeding of the rabbit fish *Siganus rivulatus* (Forsk.) in the Southeastern Mediterranean

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This paper deals with the quantitative and qualitative aspects of the feeding habits of both adolescent (< 20 cm TL) and adult stages of *S. rivulatus* in the SE Mediterranean waters off the Egyptian coast. Guts of 673 male and female specimens, ranging from 10 to 25 cm total length (TL), were analyzed. Monthly samples were obtained from the commercial fish catch landed at Alexandria fish market throughout a complete year. Fishes were measured, sexed and the stomach contents of each weighed. The food organisms in the examined stomachs were identified to the lowest possible taxon. Variations of the diet with size, sex and seasons were analyzed using the frequency of occurrence (WALKER, 1978) and percentage composition by point method (THOMPSON, 1959) together with the preponderance index (PI) (NATRAJAN & JHINGRAN, 1961). Monthly and seasonal variations in fullness coefficient (FC) and filling index (FI) were analyzed.

The present study showed that *S. rivulatus* feed on a wide variety of both plant and animal food. The plant food (green, brown, and red algae, and diatoms) was dominant and formed 70% of the stomach contents by composition and 92% by occurrence. While the total animal food (Bryozoa, Crustacea, Polychaeta, Mollusca) was less, forming 28% by composition and 42% by occurrence; Green algae, mainly *Ulva* spp. represents the preferable food item taken by the fish, PI, 57%, brown algae *Cystoseira* spp. ranked second, PI, 16% while red algae (*Corallina* spp.), Bryozoa and Amphipoda came third in order of importance, annelids, molluscs and sand appeared to be inadvertently consumed. It is worth to note that *Ulva* is the most abundant genus of the green algae in Alexandria region, followed by genus *Corallina* of the red algae (KHALIL *et al.*, 1988).

No significant differences were found between the diet of males and females. In both sexes, plant foods were dominant, (PI, 83% in females and 87.7% in males), and composed 68% and 72% of the diet and occurred in 89% and 96% of the stomachs of females and males, respectively. The food items of animal origin were less important (PI 16 in females and 11 in males). It constituted 30% and 25% and occurred in 45% and 39% of the analyzed females and males stomachs, respectively.

Food composition changes with fish growth, total plant food decreased with increase in size of the fish, while the amount of animal food increased. In juvenile fish (<15 cm TL) plant foods formed 81% of the diet and occurred in 100% of the fish examined *Ulva* was the major food item (65% by composition) followed by *Corallina* and diatoms. Brown algae were almost completely absent. Animal foods were less common and formed 18.5% by composition and 23% byoccurrence. Bryozoa, amphipods and annelids were the major animal foods ingested (Figure 1). There food items (particularly *Ulva* and diatoms) are generally more common in the coastal waters where juvenile stages usually abound. These results corroborate with those reported by LA LAMI (1971). In adult fish (>25 cm TL) both plant and animal foods were quite important, they constituted 54% and 40% of the diet and occurred in 86% and 66% of the examined fish, respectively. Brown algae were the dominant items forming 32% by composition and 82% by occurrence with *Cystoseira*, *Sargassum*, and *Colpomenia* the most important. Red algae formed 14% by composition and 41% by occurrence. Green algae, and seaweed (*Posidonia oceanica*) constituted 6% by composition and 46% by occurrence. Of the animal food, Bryozoa and Amphipoda occurred in 41% and 36% and constituted 10% and 8% of the ingested food, respectively. Mollusca, Annelida, together with barnacle shells were of secondary importance. Such a change in the feeding habits is probably correlated with the behavior of the adult fish which, contrary to juvenile stages, move into deeper waters where there food items are more abundant (KHALIL *et al.*, loc. cit.).

The present results clarify that the fish exhibits substantial seosonal variation in feeding intensity ; these variations are probably related to both the behavior of the fish as well as the relative abundance of suitable food. In all seasons, plant food exceeded that of animal origin.

Juvenile fish feed more intensively (maximum FC and FI) during spring and summer, while feeding intensity was minimum in winter.

These results seem to appertain with the relative abundance of preferable food items in the coastal waters in both spring and summer seasons (KHALIL *et al.*, 1988). On the other hand, adult fish feed heavily during autumn following the spawning season in summer (May-August). In summer and winter the feeding intensity was low.

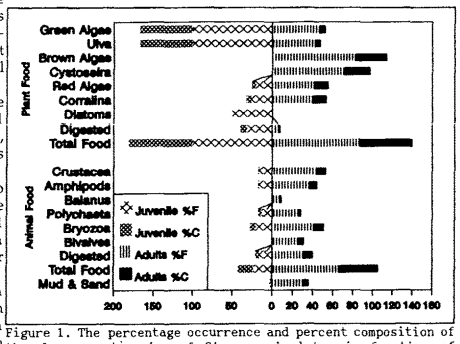

Figure 1. The percentage occurrence and percent composition of the forage catègories of Siganus rivulatus in function of size.

The decrease in feeding intensity during summer is presumably because of the large space occupied by the developed gonads, while the low winter temperature and diminished stock of suitable food may be the cause of the low feeding activity in winter. The present results clearly demonstrates that *S. rivulatus* is a herbivorous-omnivorous fish with greater preference to macrophytes. GOLANI & BARANES (1990) reported that the Mediterranean population of the two rabbit fishes *S. rivulatus* and *S. luridus* show higher trophic selectivity than the source populations in the Red Sea probably indicating their adjustment to the new environment.

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Application des modèles globaux sur l'exploitation du Pageot commun du Golfe de Gabès

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Introduction et Méthode d'Etude.

La pêche au chalut dans le Golfe de Gabès a connu ces dernières années plusieurs irrégularités, l'effort de pêche a considérablement augmenté bien que la production ait diminué pour la plupart des espèces de la zone et surtout le pageot commun *Pagellus erythrinus* (espèce principalement par ce type de pêche).

Dans ce travail, nous essayons d'analyser l'état d'exploitation de cette espèce par les modèles globaux de SCHAEFER et de FOX.

Ces deux mèthodes ont été appliquées sur les captures du pageot par les chalutiers du port de Sfax (principal port de la zone) et sur 14 ans (1977-1990).

Nous avons considéré la capture du pageot par jours de mer des chalutiers de la catégorie de puissance comprise entre 200 et 300 cv comme prise par unité d'effort standard.

L'effort de pêche standard se déduit alors en divisant la production totale du pageot des les différents chalutiers par la prise par unité d'effort standard.

Résultats et Discussion.

Les résultats obtenus par application des deux méthodes sont consignés dans le tableau 1; les courbes correspondantes sont représentées sur la figure 1.

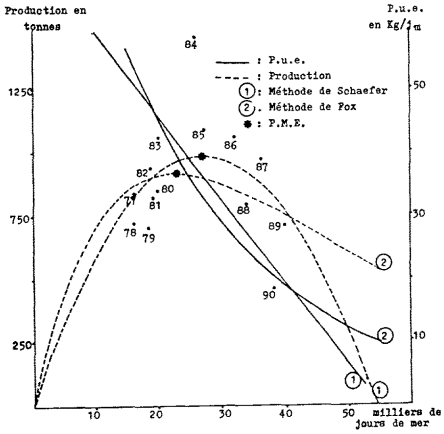
Nous remarquons que les efforts de pêche déployés depuis 1986 et 1984 dépassent l'optimum obtenu respectivement par la 1ère et la 2ème méthode; cette augmentation n'a pas entrainé une élévation de la production mais au contraire celle-ci a regressé d'une façon remarquable. Ceci laisse penser que le stock du pageot dans le Golfe de Gabès est entré dans une phase de surexploitation; nous signalions par ailleurs qu'il faudrait prendre cette évaluation avec prudence car les chalutiers du Golfe de Gabès entrent clandestinement dans les zones littorales réservées légalement aux petits métiers. Il serait intéressant alors de réduire l'effort de pêche: une telle mesure a été souvent proposée pour la préservation d'autres espèces tels que les rougets (GHARBI, 1985).

L'analyse de l'évolution de la taille moyenne du pageot débarqué par les chalutiers du port de Sfax a montré que des mesures de préservation prises en 1981-1982 et 1984 ont eu un effet favorable sur la régénération du stock (GHORBEL et BOUAIN, 1990) mais depuis 1986, ces mesures deviennent insuffisantes devant l'augmentation considérable de l'effort de pêche et le chalutage anarchique pour la capture des espèces nobles telles que la crevette et les céphalopodes (BRADAI *et col.*, 1991).

Tableau 1: Résultats obtenus par application des modèles globaux de SCHAEFER (1) et de FOX (2). (J.m. = Jours de mer)

	(1) Pue = Ad + B	(2) Log Pue = B + Af ou Pue = Uoo e^{-bf}
A	$-1.325\ 10^{-3}$	$-4.404\ 10^{-5}$
B	+72.170	+4.695
R	-0.846	-0.845
foot	27238 j.m.	22806 j.m.
P.M.E.	982.893 kg.	914.162 kg.

Figure 1: Modèles globaux appliqués aux captures du pageot dans le Golfe de Gabès. P.U.E.: Prise par unité d'effort; P.M.E.: Productions maximales équilibrées.



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V

Bottom catches along continental shelf of W. Mediterranean (Spain) of Curled Octopus (*Eledone cirrhosa* Lam.) Fishery

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Trawl survey studies during the mounths of May-July 1990 were undertaken in the continental shelf of Catalan sea (W. Mediterranean, Fig. 1). Besides quantitative studies of demersal resource characteristics, a preliminary investigation of trawl efficiency was undertaken. Two commercial trawler both of 50 HP, carried out the field work.

The analyses of catches for two gears used in a coastal fishing along W. Mediterranean coast localities was studied. The mean objective was studied the octopus fishery for his control and protection on a scientific basis.

These surveys are situated in two specific areas (Palamos and Tarragona), divided in two strata under bathimetric criteria (30100 m and 101--200 m). Trawling is done during dayliht, and tows were 1/2 hour long. All strata are divided into units of 25 square nautical miles (5*5). The number of hauls in each startum is proportional to its area and selection is made by random sampling. Software used for all data procesing it's compiled under program "CAMP" (SANCHEZ F., 1990) writted in dBase III plus.

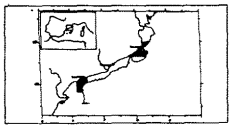

Fig. 1. Area prospected.

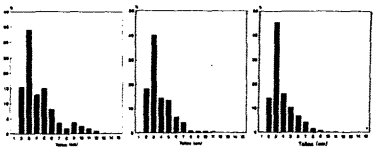

Fig. 2. Length frequency *E. cirrhosa*

The special morphology and oceaonagraphic charactarestics of area studied was determined (LLEONART J. *et al.*, 1988) a very important fishery. The abundance index it's related for the most important species (Table 1.) : Hake and Curled Octopus.

Hake (*Merluccius merluccius*). The stratified abundance index, in kg/haul for the all mounths (Table 2.), show a similar trends under 1 kg/haul, exceptioned in June (110 m depth). The abundance index shows similarity along the survey time. The same circumstances with recruitment index was founded (Table 3).

Curled Octopus (*Eledone cirrhosa*). The abundance index shows great similarity with other species founded in this area. The stratified abundance index show a downward tendency along the mounths (Table 2). In number of individual we founded the same trend. The recruitment index variations (Table 3) showing the same tendency with values varying between 78 and 30 inds. less of 7 cm. The curled octopus population is distributed over the whole continental shelf. Length frequency distribution is given in fig.2. In the experience was mesured 1049 inds. and the lengthweigth relationship obtained was:

$$W = 5.86*10^{**} -3(L^{**}2.39) \qquad R = 0.97$$

Table 1

TOTAL AREA Abundance index (kg/½ hour)	May	June	July
E. cirrhosa	1.86	1.76	1.54
M. merluccius	0.51	1.11	0.66
TOTAL FISH.	5.79	8.56	6.80
TOT. CRUSTAC.	0.26	1.38	1.22
TOT. MOLUSCA	2.79	2.24	2.10

Table 2

BIOMASS (kg/½hour) Stratified abundance index					
Strata		30-100m		100-200m	
		Weigth	Num.	Weig.	Num.
	May	0.39	15	0.56	78
M.m	June	0.45	15	2.12	166
	July	0.52	9	0.73	45
	May	1.46	13	2.08	57
E.c	June	1.98	23	1.43	39
	July	1.00	9	1.82	44

Table 3

Recruitment index
Merluccius merluccius Nº indivs. < 17 cm in 1 hour trawl

Mounth	Strata	Palamós			Tarragona			Total		
		Yst	Syst	N	Yst	Syst	N	Yst	Syst	N
May	Total	195	52.01	14	56	11.81	7	108	20.77	21
June	Total	204	55.92	17	14	2.25	6	79	20.86	23
July	Total	117	10.32	16	17	9.77	8	55	16.24	24

Eledone cirrhosa Nº indivs. <7 cm in 1 hour trawl.

Mounth	Strata	Palamós			Tarragona			Total		
		Yst	Syst	N	Yst	Syst	N	Yst	Syst	N
May	Total	55	11.94	14	92	24.36	7	78	15.91	21
June	Total	65	10.42	17	28	9.00	6	30	4.25	23
July	Total	54	4.86	16	62	31.36	8	59	19.75	24

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The spawning period of the Sole (*Solea solea* L.), population and distribution ef eggs and larvae of Sole in Izmir Bay

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The sole is one of the important fishes for the Izmir Bay, with a not determined period of spawning (URBAN and ALHEIT, 1988). The spawning periods of the sole were found as February, March, April and May for Villefranche in the Mediterranean (SARDOU, 1970), and as December, January, February, March and April (MATER, 1981) for the Izmir Bay.

In order to determine the spawning period of the sole, this study used the distribution of eggs and larvae aswell as gonadosomatic indexes. The distribution of eggs and larvae according to the physico-chemistry of the stations was also studied (ºC, S‰, O_2, pH).

Sampling was done over a period of one year (1989-90) with monthly intervals. The soles were caught by gill nets, their eggs were collected from plancton using plancton nets, horizontally (during 20 minutes, at a speed of 2 mil/h). Vertical sampling was also done, in January, the highest spawning period. The mesh size of the plancton net is 500 µm (Hensen type). The gonadosomatic index (G.S.I.) was calculated using the following formula:

$$G.S.I. = \frac{\text{Weight of gonad}}{\text{Fish weight (without gonad)}} \times 100$$

The mean diameter of the eggs was calculated as 1.19 mm (1.08 mm - 1.26 mm). Among the stations, the maximum number of eggs was collected in Guzelbahçe and the minimum number in Tuzla (Fig. 1,2).

The spawning period of sole was determined including the months December, January, February and March in Izmir Bay (Fig. 3). It was deduced that the gonads were ready to spawn in these months because most of the eggs were collected in February (47 eggs) and the G.S.I. was highest (6.86) in December (Fig. 4). The G.S.I. of sole and the amount of eggs collected from the plankton during the whole year were in harmony. The temperature of the sea water ranged between 12.5ºC and 14ºC during the spawning period.

MONTH	DECEMBER		JANUARY		FEBRUARY		MARCH		TOTAL	
STATION	Egg	Larva	Egg	Larva	Egg	Larva	Egg	Larva	Egg	Larva
1. Güzelbahçe	22	--	14	--	3	--	3	--	42	1
2. Tuzla	1	--	3	--	--	--	1	--	5	-
3. Kirdeniz	--	--	15	--	3	--	--	--	18	-
4. Uzunada	10	--	3	--	12	--	--	--	25	-
5. GÜlbahçe	--	--	2	--	29	--	--	--	31	-
Total	33	--	37	--	47	--	4	--	125	1

Table 1. The seasonal abundance of the sole *S. solea* eggs and larvae (1989-90), according to stations in Izmir Bay.

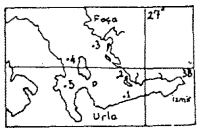

Fig. 1. Izmir Bay and the stations.

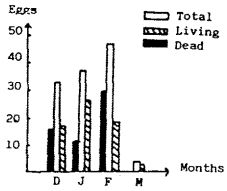

Fig. 2. The seasonal abundance of sole S. solea eggs (1989-90) in Izmir Bay.

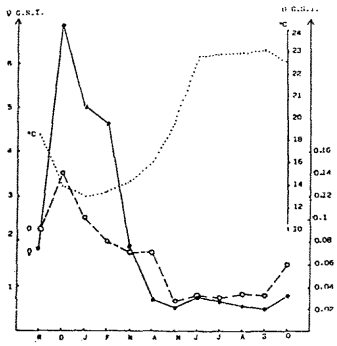

Fig. 3. Gonadosomatic index (G.S.I.) of sole S. solea.

	Females				Males		
MONTH	n	min.-Max. G.S.I.	Mean of G.S.I.	n	min.-Max. G.S.I.	Mean of G.S.I.
May	5	0.3-0.8	0.57±0.09	2	0.02-0.03	0.02±0.003
June	7	0.5-1.2	0.8±0.01	8	0.01-0.08	0.03-0.007
July	3	0.4-0.9	0.7±0.15	1	0.03	0.03
August	6	0.4-0.7	0.6±0.05	6	0.02-0.05	0.04±0.01
September	3	0.12-1.05	0.52±0.28	7	0.01-0.06	0.03±0.01
October	6	0.5-1.1	0.81±0.09	16	0.03-0.1	0.06±0.05
November	10	0.4-5.8	1.84±0.6	1	0.09	0.09
December	14	0.6-18.9	6.86±1.4	12	0.1 - 0.2	0.14±0.03
January	6	0.6-18.5	5.03±2.8	1	0.1	0.1
February	15	0.5-18.3	4.65±1.25	10	0.04-0.1	0.085±0.008
March	5	0.4-4.2	1.9±0.75	5	0.06-0.08	0.07±0.005
April	3	0.6-0.8	0.7±0.08	1	--	0.07

Table 2. Minimum, maximum, mean and standard error of mean G.S.I. (between individuals of 20-30 cms).

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Commercial fishery of *Sardina philchardus* Walb. fry in the Gulf of Salerno (Southern Italy): ichthyofaunal composition

M. IANNIBELLI & D. LEVI

I T.P.P., C.N.R., MAZARA DEL VALLO (TP) (Italy)

Our study is based on the fact that in Italy *Sardina pilchardus* (Walb) fry fishery is allowed for commercial purposes, even if for only two months in a year. However, it has always been a hard and delicate task to ascertain whether the catches of sardine fry might be noxious for the species accidentally captured. The great number of provisions, decrees and laws about this kind of activity can confirm this observation, but they often totally disagree, even though basea on the opinion of reliable experts and researchers in fishing problems and fauns management as clearly recently reviewed (IANNIBELLI, 1983; IANNIBELLI e LEVI, in prep.).

In order to provide a further contribution to the unresolved problem, a research program was carried out beginning from the fishing season, 1981, in order to collect recent and reliable data on the biological and economical aspects of the exploitation of this pelagic resource (IANNIBELLI, 1983). In this study the Gulf of Salerno was chosen as sampling area, that resulted to be, from a preliminary investigation, one of those still most interested by this kind of activity.

In the first year of research, the catch period of the sardine fry was between March 9th.- April 17th, 1981, during which we have put out to sea four times, using some of the motorboats usually operating in the area. For each day of survey one sample was collected in each of the areas mostly frequented by the different boats on that day.

The samples of about 100 grs. of weight each were taken directly from the commercial catch and then put very delicately in some cellophane bags. where the fixative liquid was added (formaldehyde at 4% in sea water neutralized with sodium carbonate, following the indications of MOTODA *et al.* reported by STEEDMAN (1976). Samples were identified in laboratory by binocular stereozoom microscope observation, according to ABOUSSOUAN (1964); ARBAULT et BOUTIN (1968), LEE (1966), LOZANO REY (1960), NICHOLS and WOOD (1976), PERLMUTTER *et al.* (1957), SAVILLE (1964), TORTONESE (1975), as well as the monography n°38 of the series "Fauna e Flora del Golfo di Napoli"(1956).

Faunal composition of the collected material resulted to be mostly constituted by *Sardina pilchardus* (Walb) (21267 specimens) but with the presence also of *Pomatoschistus marmoratus* (Risso)(Gobiidae, 255 specimens) and of *Aphia minuta* (Risso)(Gobiidae, 114 specimens). Much less numerous instead the specimens of *Pagellus bogaraveo* (Brunn.) (Sparidae, 12 specimens), of *Liza aurata* (Risso) and *Liza ramada* (Risso)(Mugilidae, 5 and 2 specimens respectively) as well as *Crystallogobius linearis* (Dub. Kor.)(Gobiidae, 2 specimens). Also the presence of *Boops boops* (L.) (Sparidae, 1 specimen) and of 1 Gadoid of very reduced size was noted.

Analyzing these results it is evident the sardine fry exploitation for commercial purposes is based almost exclusively not only on the stocks of the above Teleostean but also on two species of Gobiidae, for the number extremely reduced of captured specimens of other species. However, it is to be noted that *Aphia minuta*, which is a goby of a very reduced size for its whole vital cycle,has always been captured for commercial purposes, but the quantity that was caught in the kind of fishery investigated cannot be considered a problem for the protection of this species.

The same observation can be made on *P. marmoratus*, which is the most represented species after *Sardina pilchardus*. The capture of this goby cannot be considered particularly relevant as it does not seem to be "target species" of any other specific fishing activity, and it is to be considered ubiquitous in the Mediterranean Basin (MILLER, 1973, 1986; TORTONESE, 1975).

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Fishery and Growth of *Aphia minuta* off Majorca Island

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Aphia minuta or "jonquillo" is a pelagic neritic species, belonging to the family Gobiidae, captured around Majorca Island during the months of December through March by the artisanal fishery fleet. Its importance is based on the fact that it has a great acceptance on the market together with the price it reaches, and because it is one of the few specific fisheries of the winter season for the coastal fleet.

The "jonquillo" is captured with a fishing-net ("jonquillero") which combines purse-seine and trawling. This species meets during the winter months forming shoals for reproductive purposes. Its pelagical habits during this period allow finding them easily using the echo sounder. They are basically found inside the bays (Palma, Pollensa and Alcudia), at bottoms between 20 and 70 meters of depth, above sand and seaweed areas (*Posidonia oceanica*).

In figure 1 the importance of captures of "jonquillo" from Majorca Island in the last ten years can be observed, with amounts that lay between 20 and 80 metric tons.

The length-frequency distribution from December 1990 to March 1991 is shown in figure 2. The range of sizes oscillates between 14 and 45 mm. The average size by month is doubled from the beginning to the end of the season.

Batacharya's Modal Progression Analysis (1967) was applied to these data, in order to identificate different cohorts. In table 1 we may observe a monthly series of length modes which go on evolving in time. The mean average increases by month.

To interpret these data and being *Aphia minuta* a species of one year of life span, we determinated the age of the individuals by using the daily growth rings on otoliths *sagit-ta* (METHOT and KRAMER, 1979).

The otoliths (N = 20) belonged to fishes between 17 and 44 mm of total length corresponding to ages from 64 to 217 days. The good accordance on sizes and age strongly suggested the adecuation of the daily rings for ageing the species. However, further validation is necessary.

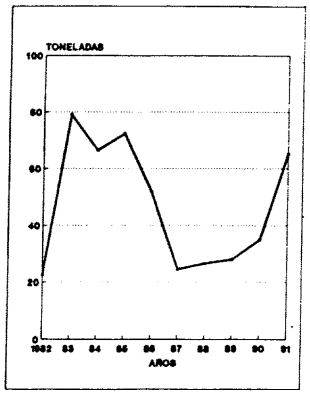

Figure 1.- Captures from 1982-91.

The growth parameters (VON BERTALANFFY, 1938) were calculated by a stadistical programme which uses the Marquant's algorithm ("Fishparm") by the iterative calculation of parameters, and by the method based on the length-frecuency analysis ("Elefan", PAULY and DAVID, 1981).

The growth parameters determined are :

1) Otoliths : L_∞ = 42.62 mm ; K = 6.35
2) ELEFAN : L_∞ = 45.62 mm ; K = 6.352 ; t_0 = 0.1123.

XII	I	II	III	IV
	17	19	25	27
25	26	30	33	34
30	35	38	39	39
35	39			

Table 1.- Modal clases by month.

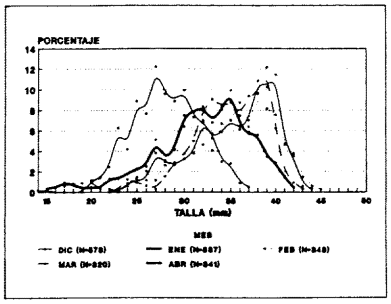

Figure 2.- Length distribution of "jonquillo" off Majorca.

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V

Age and growth of Black Scorpionfish, *Scorpaena porcus* L., 1758, in the Adriatic Sea

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Black scorpionfish, *Scorpaena porrus*, is the most abundant species of Scorpaenidae family along the eastern Adriatic coast. It lives on the bottom, at small depths. Therefore this species is an important fishing object of different coastal fishing gear, particularly trammels and "strasin". In the 1982-1988 period these fish made up 35. 6% of the number and 28,7% of the weight of fishes occupying the top position (JARDAS and PALLAORO, 1989). After these authors their proportion in catches showed an increase trend in the 1962-1982 period.

Material and methods

Age and growth was studied from a total of 377 black scorpionfish specimens caught by trammels along the Croatian Adriatic coast between September 1986 and December 1990, mainly in summer (213 individuals) during intensive spawning. Fish length was 58-300 mm (Lt), weight 13-585 g. Age was determined by otolith reading.

Results

Fish age from the collected material was 1 to 11 years. The fish of 2-4 years of age were best represented (59.4%). (Table 1). Mean length and weight were determined for each age groups (Table 2). FORTUNATOVA (1949) obtained considerably lower mean lengths for all estimated ages (1-6), particularly for the first three to four years of these fish from the Black Sea (Sevastopol region).

Table 1.- *Scorpaena porcus* - Size and estimated age of 377 specimens studied.

Lt (mm)	Estimated age 1	2	3	4	5	6	7	8	9	10	11	N
50 - 59	1											1
60 - 69	5											5
70 - 79	1											1
80 - 89	3											3
90 - 99												
100 - 109		2										2
110 - 119		5										5
120 - 129		17										17
130 - 139		36										36
140 - 149		4	25									29
150 - 159			37	4								41
160 - 169			11	32								43
170 - 179			2	29	2							33
180 - 189				19	13	3						35
190 - 199				1	17	8	3	2				31
200 - 209					4	14	2	3	3			27
210 - 219						6	7	2	2	3	1	21
220 - 229						4	6	3	1	1	1	16
230 - 239							2	2	2		3	10
240 - 249							1	4	3	3	3	14
250 - 259								1	1		1	3
260 - 269									1	1		2
270 - 279												
280 - 289										1		1
290 - 299												
300 - 309											1	1
N	10	64	75	85	36	35	21	17	13	11	10	377
%	2.6	17.0	19.9	22.5	9.5	9.3	5.6	4.5	3.4	2.9	2.6	

Table 2.- *Scorpaena porcus* - Average length and weight per age.

Age	1	2	3	4	5	6	7	8	9	10	11
$\bar{X}_{Lt}$ (cm)	6.99	12.96	15.28	17.15	18.94	20.39	21.46	22.21	22.28	23.51	24.30
$\bar{X}_{W}$ (g)	7.9	39.9	61.3	93.8	131.8	168.4	191.4	222.4	246.9	262.3	289.5

Values of growth parameters after von Bertalanffy's growth equation, obtained from Table 2 for both sexes together were:

$$L_\infty = 28.2 \text{ (cm)} \qquad K = 0.182 \qquad t_0 = -0.80$$

Characteristic growth curve obtained from the above values is shown in Fig. 1.

The length (Lt cm) weight (g) relationship for both sexes together gave the equilibrium constant b = 3.034, pointing to isometric growth. Characteristic length-weight relationship curve is shown in Fig. 2. Condition factor obtained from this relationship was c.f. = 1.878.

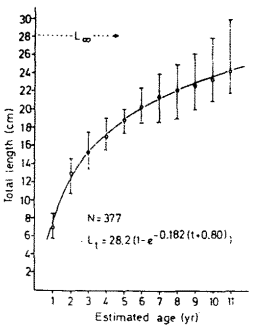

Fig. 1.- *Scorpaena porcus* - growth curve

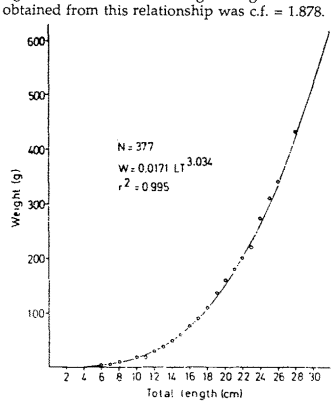

Fig. 2.- *Scorpaena porcus* - Lenght - weight relationship curve

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Occurrence of the unihorn octopus *Scaergus unicirrhus* in the Sicilian Channel. III : Description of features

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The unihorn octopus *Scaergus unicirrhus* Orbigny, 1840, occurs more frequently in the Sicilian Channel (Central Mediterranean Sea: JEREB & RAGONESE, 1990) than in other areas of the Mediterranean (MANGOLD & BOLETZKY, 1987) where the species was firstly described and is considered endemic (MANGOLD & BOLETZKY, 1988).

At Mazara, this species is well commercilized even though its economic value remains inferior to that of other octopuses (JEREB & RAGONESE, 1990; RAGONESE & JEREB, 1990). Local fisherman call it "purpu ricciu" ("curly octopus") due to its main characteristic feature, i.e. the presence of round cutaneus papillae (or warts) all over the mantle.

Systematically, however, the species differs from all other octopuses for the typical hectocotylus (with a large deep-spoon chaped ligula) and a very long diverticulum of the penis.

In this note the descriptive features of adult specimens of both sexes for the Siclian Channel population are reported for the first time. The gonadic apparatus in different developmental stages is also described in both males and females.

Observation come from experimental trawl surveys carried on by our Institute (see LEVI, 1990, research program TRAWL, for futher details) combined with ancillary information collected among local fishermen.

In both male and female specimens the characteristic papillae are very prominent on the dorsal mantle surface, where they seems to form linear ridges. They are almost undistinguishable on the ventral surface, which appears smooth and has a rather uniform withish color even in the live animals. The dorsal mantle coloration is very variable, going from reddish brown with golden-yellow reflection and greenish blue iridescenze to green blue dominant tones with reddish brown spots.

The mantle is oblong and compact, with a distinguishing peripheral ridge that encircles the lateral edge, dividing the dorsal from the ventral surface and forming the characteristic lateral pallial fold (VOSS, 1951; SANCHEZ and ALVAREZ, 1988).

The head is narrower than the body, with slinghtly prominent eyes and a bifid cirrhus over each eye. The arms are subequal except the III left one in adult male, which is shorter and bears the extocotylus (but see JEREB *et al.*, 1989, about some anomalies observed).

These morphological characteristic and the coloration observed, agree with other descriptions of the genus which is considered to be monospecific (ROBSON, 1929; VOSS, 1951; MANGOLD & BOLETZKY, 1987; SANCHEZ & ALVAREZ, 1988).

Some differences are detectable in the habitus of the two sexes : females exibit a more delicate structure than males, with a narrower and a more elongate mantle, thinner arms and much smaller proximal suckers.

The enlarged proximal suckers in adult males which characterize also three other Mediterranean octopuses, namely *Octopus vulgaris*, *O. macropus* and *O. salutti*, seem, to have a significant role in reproductive behaviour (MANGOLD & PORTMANN, 1964), being displayed in front of the female as a clear sign that the other sex is present.

The gonadic apparatus generally conforms to the octopus-like scheme. In immature males the testis is more or less bulky, with a scarcely visible spermathophoric gland and Needham's sac; the penis and its diverticulum are very thin and translucent. The maturing testis is bulkier with the spermatophoric gland already evident as well as Needham's sac Howdever, only few, scarcely-formed spermatophores are present; the penis and its diverticulum are thicker and opaque. At the fully mature stage the testis is very bulky, the spermatophoric gland is fully developed and Neddham's sac contains well developed spermatophores (up to 12-14 with a length range of 30-52 mm) which can also be found in the diverticulum and in the penis.

Immature females have a hemispheric milk-white ovary; the proximal part of the oviducts is thin, filiform and almost transparent, and the oviducal glands are very smalls; the distal oviduc parts are slightly thicker. The maturing ovary occupies a large portion of the pallial cavity (overlapping the oviducal glands when the mantle cavity is open), and it is light straw-coloured, with the eggs (2.2.5 mm long) visible through the transparent ovarian membrane.

No morphological variation was observed between *Scaergus unicirrhus* specimens coming from the different "subareas" investigated, This is in good agreement with the existence of a "unit" population of the unihorn octopus in the Sicilian Channel.

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Possibility of hybridization between *Dentex Dentex* and *Pagrus Major*, a transplanted fish species into the Adriatic Sea

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Owing to the factors of ecological and ethological isolation between species, the rate of natural hybridization in fish is very low. However in some cases the frequency of natural hybrids may increase considerably. HUBBS (1955) observed that hybridization is often a function of the integration of the habitat and that species that are segregated in breeding can tend to breed together where the environment is rendered intermediate either through natural causes or through modification by man. Thus, it may be that when there is gametic compatibility, such hybridization does occur between totally allopatric species artificially grouped in the same environment (CHEVASUS, 1979).

This paper reports on artificial hybridization between red sea bream *Pagrus major* and common dentex *Dentex dentex*, as an indication of possible natural hybridization. Red sea bream was transplanted into Adriatic fish farms, as species commercially very interesting and its breeding was successful. They even matured spontaneously in the Adriatic in April-May which confirms their good adaptation to this environment.

Most of the species common dentex and red sea bream parental stock matured spontaneously under ambient conditions in the middle of May, in the Hatchery of the Institute of Oceanography and Fisheries in Split, giving small quantities of ripe eggs and milt. Therefore they were stripped of gametes. Results of the trials on artificial reproduction and larval rearing of common dentex, red sea bream and their reciprocal hybrids are given in Table 1.

Table 1. Results of trials on artificial reproduction of *Dentex dentex*, and *Pagrus major* and their reciprocal hybrids.

	Fecundity (number of eggs)	Number of fertilized eggs	Fertilization (%)	Hatching (%)	Mean hatching time (hours)	Total length of larvae (mm) ± SD: newly hatched	after yolk sac absorption	30 days old larvae	Survival after 30 days (%)
Dentex dentex	45 000	20 000	83	62	60.15	2.28 ± 0.02	3.49 ± 0.02	6.08 ± 0.11	8.1
D.dentex ♀ x *P.major* ♂		20 000	77	56	58.00	2.31 ± 0.03	3.55 ± 0.02	6.15 ± 0.84	6.5
Pagrus major	161 000	20 000	90	40	53.30	2.19 ± 0.02	3.37 ± 0.02	4.65 ± 0.08	11.2
P.major ♀ x *D.dentex* ♂		20 000	82	50	53.45	2.19 ± 0.08	3.51 ± 0.05	4.67 ± 0.07	9.0

Percentage of fertilization and hatching in hybrids slightly disagree with that of the parental species and showed high gametic compatibility between studied species. The duration of the embryo development and the length of newly hatched larvae showed evident maternal effect in both hybrid combinations. After hatching four studied combinations were placed in two larval tanks each. The larval rearing method was described by JUG-DUJAKOVIC and GLAMUZINA (1988).

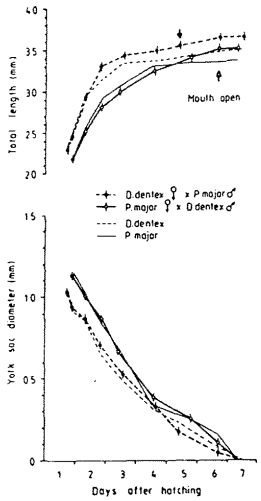

Fig. 1. Growth and yolk sac resorption of *Dentex dentex*, *Pargus major* and their reciprocal hybrids at constant temperature (17±0.5°C)

Distribution of total lengths with standard deviation and yolk-sac resorption for the yolk-sac larvae of common dentex, red sea bream and their reciprocal hybrids are shown in Figure 1. There was no significant difference between Hybrids and maternal species (T-test, P<=.05; SOKAL and ROHLF, 1969).

There was no significant difference in survival from hatching to day 30 (G-test of independence; SOKAL and ROHLF, 1969) and growth (ANOVA, P<0.05) between hybrid and maternal species (Table 1) in both hybridizations.

The results of this experiment confirm the possibilities of natural hybridization between common dentex and red sea bream, the species transplanted into the middle Adriatic where common dentex existed before. This calls for the control of natural sparid population for detection of eventual natural hybrids and their viability and great prudence in future introducing an allopatric species into an environment already populated with the same family.

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Fishery-biology studies in the Bay Tarska Vala (Istrian Peninsula - Adriatic Sea)

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The bay Tarska Vala is situated on the Western coast of the Istrian Peninsula. As to the productivity, it is particularly rich habitat of many marine fishes. Traditionally, the bay has been fished twice a year, in spring and autumn, for more than 900 years (Fig.1).

Preliminary fishery-biology studies of Tarska Vala started in 1989. A total of 13 fish species and 2 cephalopod species were recorded (Table 1). Average catch was around 25,000 kg for the 1981-1991 period, ranging from 4,000 kg (1987) to 80,000 kg (1990).

Numerically best represented species in analyzed catches were: *Liza aurata* - 43.4%, *Lithognathus mormyrus* - 16.4%, *Dincentrarchus labrax* - 10.3% and *Liza ramada* - 9.4%.

Weight of the catches showed the dominance of the following species: *Dicentrarchus labrax* - 26.1%, *Liza aurata* - 25.4%, *Liza ramada* - 13.0% and *Lithognathus mormyrus* - 10.5%.

Liza aurata (Fig. 2) were best represented in this and all the earlier catches; analyzed individuals of 22.3-36.6 cm length range and mean length XLt = 29.13 cm belonged to the third, fourth and older age groups and for the most part (more than 85%) exceeded minimum length at first maturity (up to 26 cm) (MOROVIC, 1962). A comparison of the mean lengths of analyzed specimens of all the catches realized by now (Nov., 1989 - XLt = 27.85; Dec., 1990 - XLt = 29.05; May, 1991 - XLt = 29.81; Dec., 1991 - XLt = 29.13) showed very small departures and a slight increase trend confirming that this population is, for the time being, normally regenerated and recruited. Fish from autumn catches were already spawned which is in agreement with their rare records from the Mediterranean (HELDT, 1948).

Dicentrarchus labrax (Fig. 3) is a permanently present species in the catches with rather considerable variations in quantity; 68 analyzed specimens of 30.5-88.0 cm length range and mean total length XLt = 41.17 cm belonged to the third to eleventh age groups. Minimum total lengths of males at first maturity range from 23 to 32 cm. Therefore, only a small proportion (4.5%) of specimens (taking upper length values as relevant) was below permissible limit. However, sexual maturity was established in the smallest specimens by milt striping. So it may be stated that almost exclusively mature individuals were caught. A comparison of mean total lengths of specimens of all the catches realized by now (Nov., 1989 - XLt = 35.25; Dec., 1990 - XLt = 47.58; May, 1991 - XLt = 33.55; Dec., 1991 - XLt = 41.17) showed that they were rather low, particularly in some of the catches, but still within permissible limits.

Lithognathus mormyrus. Analyzed specimens of 15.7 to 32.7 cm length range and mean total length XLt = 25.89 cm belonged to the 2+ age group and older. Sexual maturity in this protandric hermaphrodite species occurs at 20 cm length in males and at 25 cm in females. Analyzed sample, sex excluded, contained about 18% immature individuals. However, a comparison of mean lengths of the fish in the catches realized by now (Nov., 1989 - XLt = 24.52; Dec., 1990 - XLt = 26.17; May, 1991 - XLt = 27.56; Dec., 1991 - XLt = 25.89) showed their irregular oscillations within narrow limits, with no defined trend. This points to the fact that length frequency distribution of this species was more or less identical, with slight departures, throughout the period of our study.

Liza ramada occurred in larger numbers only from time to time; of 62 analyzed specimens of 29.0 to 62.0 cm length range and mean total length XLt = 37.70 cm, 5% specimens were immature (after available data for the Adriatic they attain first maturity at 30 cm length).

There is no need to limit the fishing in Tarska Bay.

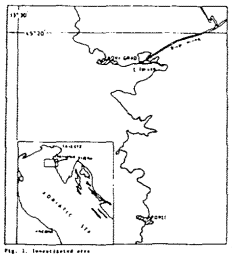

Fig. 1. Investigated area

Species	Date	$\bar{L}_t$ ±SD	Range	$\bar{W}_t$ ±SD	Range	$\bar{L}_w$ ±SD	Range	n
Liza aurata	11.1989	27,45 ±3,022	21,0-36,0	13,29 ± 1,331	10,0-23,3	167,25 ±35,100	40,0-330,0	190/150
	12.1990	29,03 ±3,206	26,1-41,4	12,82 ±0,959	11,2-17,9	183,90 ±37,943	90,0-341,3	539/100
Lithognatus mormyrus	11.1989	24,32 ±3,317	18,5-31,3	13,98 ±2,081	13,0-20,0	190,64 ±42,433	70,0-393,0	67
	12.1990	26,17 ±3,293	18,0-31,0	14,31 ±2,047	11,4-20,7	216,76 ±45,388	49,9-433,3	42
Sparus aurata	11.1989	18,95 ±4,892	17,5-23,5	-		109,00 ±39,647	70,0-190,0	10
	12.1990.	20,84 ±3,334	17,4-29,0	14,42 ±2,386	12,2-19,7	123,40 ±35,316	66,3-306,6	13
Dicentrarchus labrax	11.1989	35,25 ±4,444	29,0-39,5	19,13 ±3,658	16,0-22,5	443,50 ±172,899	240,0-660,0	4
	12.1990	47,58 ±15,473	31,2-80,0	23,70 ±4,937	17,0-44,0	1376,33 ±1445,657	296,9-3868,0	21
Liza ramada	11.1989.	38,50 ±4,555	33,5-43,0	18,50 ±2,121	15,0-20,0	321,00 ±188,024	280,0-370,0	5
	12.1990	39,50 ±3,536	36,8-42,8	17,45 ±0,495	17,1-17,8	485,00 ± 91,924	420,0-550,0	2
Mugil cephalus	11.1989	31,00 ±4,715	25,0-43,5	16,77 ±3,411	13,0-23,0	311,11 ±233,313	130,0-803,0	9
	12.1990	32,8		27,2		33,30		1
Liza saliens	12.1990	37,18 ±4,682	32,7-41,2	17,84 ±2,551	14,4-18,7	473,48 ±196,385	243,0-577,0	4
Lichia amia	11.1989	31,5		21,0		280,0		1
	12.1990	37,45 ±1,765	33,6-40,1	23,07 ±0,916	22,0-24,5	455,67 ±46,350	395,0-503,0	6
Trachurus mediterraneus	11.1989	27,00 ±1,261	26,0-28,0	-	-	145,00 ±33,355	120,0-170,0	2
Alosa fallax nilotica	12.1990	35,03 ±4,116	29,4-40,0	17,46 ±2,189	15,0-20,1	348,08 ±155,261	194,3-534,7	3
Umbrina cirrosa	12.1990	43,93 ±11,3[illegible]	36,2-61,1	-	-	1110,08 ±33,430	516,0-2130,0	4

Tab. 1. - Catch structure from Tarska cove (1989, 1990).

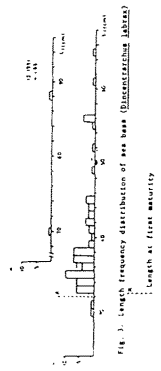

Fig. 3. Length frequency distribution of sea bass (*Dicentrarchus labrax*)

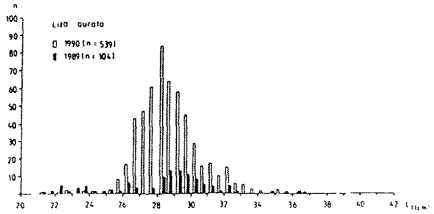

Fig. 2. Length frequency distribution of golden grey mullet (*Liza aurata*).

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V

Nouvelles observations sur *Ommastrephes bartrami* (Lesueur,1821) (Cephalopoda, Ommastrephidae) dans le Bassin Méditerranéen Oriental

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Pendant les recherches scientifiques menées à partir de *"R/V K. Piri Reis"* dans la partie sud de la Mer Egée, nous avons constaté que les lumières du bateau attiraient un certain nombre de calmars. Ces calmars pêchés ont été identifiés comme l'espèce *Ommastrephes bartrami*. Pour l'identification de cette espèces, on a utilisé la structure des dents, des massues tentaculaires et de l'hectocotyle. En Méditerranée, l'existence de cette espèces a été signalée de la Mer Ligure par RELINI (1990) et de la Mer Adriatique par BELLO (1990).

Les individus étudiés ont été prélevés près de la surface en 5 stations sur les fonds de 800 a 2200 mètres qui se trouvent dans la partie sud de la Mer Egée (Fig.1).

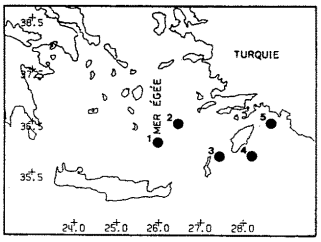

Fig. 1.- Les stations de prélèvements

Au cours de travaux effectués dans ces stations, nous avons rencontré *O. bartrami* en grande quantité surtout durant la saison d'automne. L'abondance de cette espèce diminue de l'hiver au printemps, et elle disparaît en été.

L'étude de la distribution verticale, diurne et nocturne, de cette espèce par les écho-sondeurs ATLAS-DESO-10 et SIMRAD EK-400, nous a montré qu'elle se situe entre 200 et 250 mètres de profondeur (Fig. 2). A partir de l'allumage des lumières du bateau, les calmars montaient jusqu'à 40 mètres.

Durant les années 1990 et 1991, on a prélevé 16 individus d'*O.bartrami*. Les données obtenues de ces individus sont présentées dans le tableau (Tab.I).

L'étude des contenus stomacaux montre qu'ils se nourrissent de Céphalopodes, Poissons et Crustacés.

Dans le station 4, nous avons aussi rencontré une autre espèce, *Todarodes sagittatus*. Mais cette espèce est plus abondante dans la partie nord de la Mer Egée durant la saison estivale. Il semble qu'elle tend à descendre vers le sud en relation avec le refroidissement des eaux en automne et en hiver.

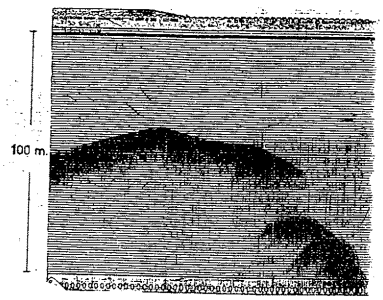

Fig. 2.- Echo nocturne d'*O. bartrami* dans la station 1.

Tableau I.- Données obtenues sur l'*O. bartrami* à 5 stations

ST.	LM(mm)	PT(gr)	Sexe	Prof.(m)	Date	Positions
1	560	8500	♀	900	17.05.90	36°10'N
						26° 01' E
2	157	95	♀	800	18.09.90	36° 46'N
						26° 32' E
3	250	420	♀	830	19.09.90	35° 47'N
	210	460	♀			27° 06' E
	230	300	♀			
	245	450	♀			
	260	500	♀			
	220	320	♀			
	160	130	♀		10.12.91	
4	275	550	♀	1300	19.09.90	35° 54'N
	320	1050	♂			28° 01'E
	275	600	♀			
5	260	700	♀	2200	11.12.91	36° 39'N
	370	1010	♀			28° 45'E
	195	510	♀			
	268	710	♀		09.03.91	

LM = Longueur dorsale du manteau.
PT = Poids total.

En conclusion, nous espérons que la présence nombreuse, d'*O. bartrami* dans la partie sud de la Mer Egée et sutout à l'extérieur de la Mer Ligure et de la Mer Adriatique, révèlera son importance pour la fauna teuthologique et pour la pêcherie de la Méditerranée Orientale.

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V

A new indo-pacific Gobiid Fish *Oxyyurichthys papuensis* (Val., 1837) for Eastern Mediterranean Coasts of Turkey

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In this investigation, *Oxyurichthys papuensis* which has been found for the first time among common Red-Sea immigrant species living in eastern-Mediterranean coast of Turkey is being reported and some characteristics of the morphometric and meristic properties of the species is also given.

Gobiidae family has a great importance by species diversity among the marine fish fauna of Turkey. Some of the researches carried out on the gobiidae family living around Turkish coasts, are SOZER (1941), AKSIRAY (1954), MILLER (1982), MATER and KAYA (1986), KAYA and MATER (1987).

Four individuals of *O. papuensis* was catched during a 30-minute trawling study in Mersin Bay between 36º 39' 00'' - 34º 55' 00'' - 34º 56' 00'' coordinates during the cruise of *K. Piri Reis* research vessel in 1991 (Fig. 1). Trawling area were 22-24 m deep with sandy-muddy bottom.

Morphologicaly, the shape of the body is similar to the other members of gobiidae family. The teeth are located as one-line on upper jaws and multi-line on lower jaws. It can be considered as characteristic properties having 5 vertical series of suborbital papilae and cirrus-like flap on the upper edge of the eyes. Table 1 shows some of the morphometric and meristic characters of samples collected during the cruise.

Table 1. Morphometric and meristic characters of the collected samples.

Samples	1	2	3	4
Total length (mm)	134.40	137.70	135.05	126.50
Standard length (mm)	98.20	97.75	97.00	93.00
Body depth (mm)	18.80	19.25	16.90	16.9
Head length (mm)	21.85	23.00	23.90	24.20
Eye diameter (mm)	5.75	6.05	5.80	6.00
First dorsal fin rays	VI	VI	VI	VI
Second dorsal fin rays	I.12	I.12	I.12	I.12
Anal fin rays	I.13	I.13	I.13	I.13
Pectoral fin rays	22	22	22	22
Pelvic fin rays	I.5	I.5	I.5	I.5
Scales in lat.series(±3)	78	80	80	76

Scales present on predorsal. Body light blue-gray, with irregular yellow band along lateral midline; head with purple and yellow streaks, eye cirrus orange. A dark spot on the caudal fin base (Fig. 1).

The other significant reports had come from BEN-TUVIA (1983) and MILLER in WITHEHEAD *et al.* (1986) on the same species living in eastern-Mediterranean basin.

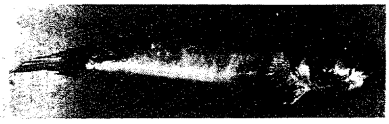

Figure 1. *Oxyurichthys papuensis* (Total length:134.40 mm).

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First examination and identification of the optimum operation period of fyke-nets with two funnels and a 42 mm mesh size in order to catch Sepia (*Sepia officinalis*) in Izmir Bay

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In Izmir Bay, Sepia (*Sepia oficinalis*) is caught using trammelnets, fyke-nets with 12 mm mesh size, and lines. This study represents the first time that fyke-nets with a 42 mm mesh size are examined. The sheme of these fyke-nets used may be observed in Fig. 1. 72 units of the before mencioned fyke-nets were used in this study, which were set at sunset and hauled by morning, approximately 12 hours afterwards.

According to the result of this study, the before mencioned fyke-nets were successful catching Sepia. In 27 days, 352 Kg of Sepia were caught. At the same time these fyke-nets are more selective than those with a 12 mm mesh size, because the crabs are not taken by them.

The amount of 114 units of fyke-nets were devided into three groups for this study:

38 units were set at sunset and hauled in the morning, 12 hours later. The amount of Sepia caught in 25 days was 352 kg.

38 units more were set at sunset and hauled after 36 hours, at the same station, resulting the amount caught in 25 days 449 Kg.

In the third group, 48 units of fyke-nets were hauled 48 hours after setting, in which 453 Kg were caught. Besides of not obtaining any increase in the productivity, this group also meant death for the Sepia.

As a results, the optimum operation period using fyke-nets was indentificated as the 36-hour one, increasing the productivity in a 24% compared to the first group.

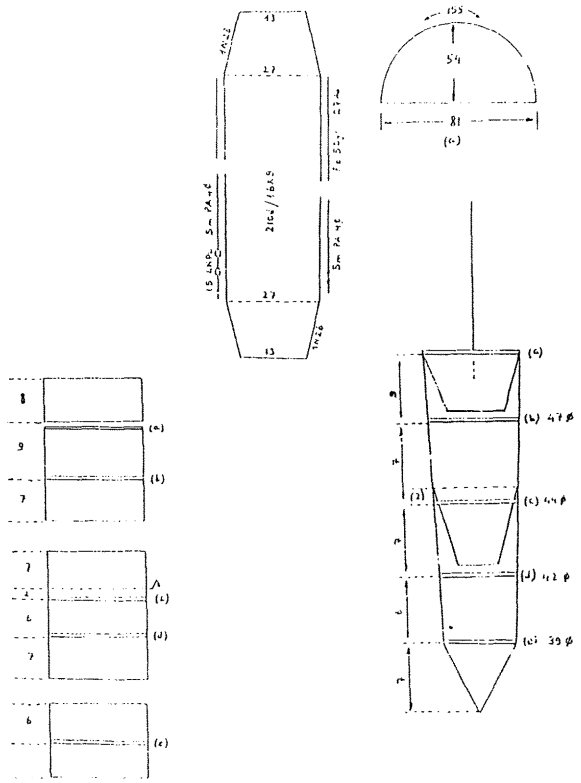

Fig. 1. Scheme of fyke nets for catching sepia

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Stock dimensions and species composition of Demersal Fish biomass in Izmir Bay

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The purpose of this study is to determine the demersal fish stock living in different dephts, between 20 and 70 mtrs, of the south and east parts comprised respectively between the following coordinates: 38°40'48"N and 26°28'20"E and 38°41'29"N and 26°42'42"E, which connect the eastern borderlands of Karaburun and Eski Foça successively.

The Izmir Bay, where in this study was carried out, has a muddy and orgillaceous ground, which is suitable for trawling.

This study was carried out with the reseach boat Hippocampus, which belongs to the Ege University Fisheries College. The bottom trawl net used during the survey had a codend mesh size of 40 mm with a high opened mouth.

The amount of demersal fish was estimated by bottom trawl and the amounts caught by this method in unit time. The different depth levels (20-40-60-70m), as well as the homogeneous distribution of distances between the stations, were considered determinating the twenty trawl stations for the study.

The species of trawl samples were selected at the end of each trawling. The main commercial fish as *Mullus barbatus*, *Pagellus erythrinus*, *Solea vulgaris*, *Merluccius merluccius*, *Trisopterus minitus capelanus* were biologically analysed.

The examination and estimation of demersal fish stock was made according to ALVERSON *et al.* (1964).

Recording to RICKER (1940) and GULLAND (1964), the total population of demersal species in an area can be estimated with the help of trawling area, catching capacity of the trawl and the catching density.

The stock dimensions in the research area can be expressed as biomass of the demersal fish, and its amount found out by measuring the commercial demersal fish.

In this study, the biomass distribution of demersal fish was found dense in the area between the exit of the interior bay and the exterior bay, estimating an amount of 2.8 tones per square mile. In the exterior bay, and the Gülbahçe Bay these amounts were estimated as 1.4 and 1.5 tones per square mile, respectively (Table 1, Fig.1).

Study Region	Avarage Depth (m.)	Scaning Ground (m2/h.)	Study Area (mile/square)	Catching of Mile Square (tone)	Production of The Ground (tone)
Interior Bay	50	37×10^3	7.19	4.600	33.070
	40	37×10^3	10.59	3.700	39.180
	30-40	37×10^3	11.69	2.780	32.500
	20-30	37×10^3	10.71	2.320	24.850
	20-25	37×10^3	6.00	1.850	11.100
	20	37×10^3	8.56	1.400	11.980
Exterior Bay	50	37×10^3	10.04	1.850	18.570
	60-70	37×10^3	46.44	1.400	65.020
	40-50	37×10^3	6.41	0.920	5.900
Gülbahçe Bay	28-30	37×10^3	1.32	4.600	6.070
	28-30	37×10^3	9.93	1.400	13.900
	28-30	37×10^3	1.98	1.480	0.950
Total			130.86		263.090

It was observed, that the depth levels in which the fish biomass had a stronger density, were between 40 and 50 mtrs in the interior bay, 50 and 70 mtrs in the exterior bay and 28 and 30 mtrs in the Gülbahçe Bay (Table 2).

Fortyfive species were determined by the trawl surveys made in the research area. These species are composed as follows: 3 Pelagic, 5 Selachii, 2 Crustacea, 4 Cephalopoda and 31 Demersal fish.

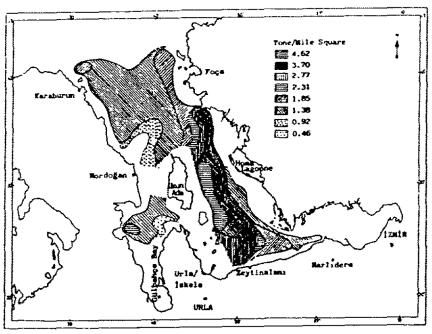

Fig. 1.- Distribution of Demersal Biomass in the Sub-Regions

Study Region	Average Depth (m.)	Scanning Ground (m/h2)	Average Catching (tone)	A catch of Mile Square (tone)	Study Area (mile aquare)	A Production of the Area (tone)
Interior Bay Gülbahçe	30-58	37×10^3	0.05	4.6	8.11	37.300
Exterior Bay Tuzla	30-40	37×10^3	0.04	3.7	10.59	39.180
Exterior Bay Tuzla	30	37×10^3	0.03	2.8	11.69	32.500
Exterior Bay Tuzla	20-30	37×10^3	0.025	2.3	10.71	24.630
Exterior Bay	40-50-70	37×10^3	0.02	1.8	18.04	33.380
Exterior Bay Tuzla	30-60	37×10^3	0.015	1.4	64.93	91.000
Exterior Bay	50	37×10^3	0.01	0.9	6.41	5.570
TOTAL					130.86	263.090

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V

Seasonal differences of some biological parameters of Striped Sea Bream (*Lithognathus mormyrus*) from the Eastern Adriatic Coast

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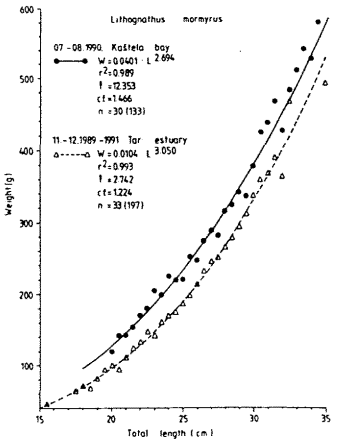
The paper presents the data on some biological parameters of striped sea bream in winter and summer season from two habitats on the eastern Adriatic coast : estuary of the Mirna River-Tar Estuary (western Istrian coast) and Kastela Bay (middle Adriatic). Material was collected in November 1989 and in July, August, and December 1990, and December 1991. A total of 330 specimens were analyzed, of which 197 originated from Tar Estuary.

Length-weight relationship ($W=a \times L^b$), condition factor (PAULY, 1984) and length frequency distribution after Bhattacharya's method (SPARE *et al.*, 1989) were calculated. Length-weight relationship (Fig. 1) shows positive allometric growth of striped sea bream in winter (Tar Estuary) and the negative one for fish collected in summer (Kastala Bay).



The value of b (Fig. 1) calculated for fish collected in November and December in Tar Estuary (3.050) does not significantly ($p<0.01$) differ from 3, and that for fishes collected in July and August in Kastela Bay (2. 694) is significantly different from 3.

Condition factor of striped sea bream in summer (c.f.=1.466) fish in winter time (c.f.=1.224). Since striped sea bream mature between the end of July and mid August the condition factor is higher and the value of b is significantly different from 3 in summer. Method for separating length frequency distribution gave better age structure for fishes collected in November and December in Tar Estuary (Chi-square value = 14.492; $x^2 = 14.067$) than for striped sea gream collected in summer from Kastela Bay (Chi-square value = 9.865; $x^2_{.05(1)} = 3.841$).

Fig. 1.- Length-weight relatlonship for the striped sea bream (*Lithognathus mormyrus* L.) in summer (Kastela Bay) and winter (Tar Estuary) season.

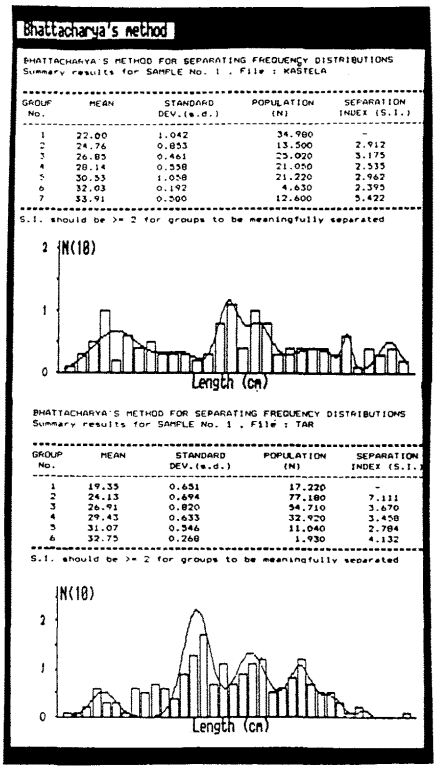


Fig. 2.- Total length frequency distribution (0.5 cm) with calculated of striped sea bream (*Lithognathus mormyrus* L.) age groups from the Kastela Bay (summer season) and Tar Estuary (winter season)

At 95% level of confidence, the expected distribution is significantly different from the observed distribution for both seasons, presumably due to small number of young fishes (1°, 2° and 3°).

Therefore, these studies should be continued.

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The demografic modeling of the Mediterranean Loggerhead Sea Turtle Population : First results

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A demographic model is an analysis tool that permits the exploration of the dynamics and the functionning of a population. We have undertaken the demographic modeling of the Mediterranean population of the Loggerhead turtle *Caretta caretta*. Because the data were sparse, we decided to consider different hypotheses, thus we constructed three models. They have been compared to that of CROUSE *et al.* (1987). Our method is more general and our results distinguish themselves from the conclusions of these authors. We present here the results of a sensitivity analysis of the population realized with the most appropriate of the three models, and we present propositions for conservation of the species.

Constructing the model. We chose a stage-structured matrix population model for two reasons : the very rare demographic data available are linked to size or fecundity stages (no method permits determining the age of sea turtles) and the size rather than the age seems to influence the demography of these marine reptiles. Starting from a synthesis of the information on the size of the individuals captured by different fishing techniques in the Mediterranean, four size-based stage classes have been determined among the young. These stage are defined by carapace length (SCCL, cm): stage classes Y1 >12-32≤, Y2 >32-51≤, Y3 >51-70< and Y4 ≥ 70. Two stages were defined for the nesting females : neophyte females and adult females. Fecundity parameters were estimated from Mediterranean and worldwide bibliographic data Transition parameters between the stages were calculated using CASWELL's work (1989), based on stage duration and on age of first reproduction. This age is unknown and three possible values were considered: 15, 20 and 25 years. We propose ranges of the possible variation for survival rates. For each age the lowest and highest values of survival rate were used in our model Hence the sensitivity analysis is based on 6 matrices (Fig. 1). The construction and analysis of the models were realized with the program ULM (LEGENDRE *et al.*, 1992).

Fig. 1. - matrix model and definition of the parameters. Pi=zi*Si, Gi=(1-zi)*Si, zi : probability of remaining in the same stage, Si : annual survival rate, F1SO=d*r*g*w*SO, F2SO=a*r*g*w*SO (F1SO and F2SO representing the fecundity), r : sex ration, d : coefficient of egg productivity in neophytes, a : annual proportion of reproductive adults, g : cluth frequency, w : cluth size, SO : survival from egg to age one year, Sa : adult annual survival rate.

$$\begin{matrix} P1 & 0 & 0 & 0 & F1S0 & F2S0 \\ G1 & P2 & 0 & 0 & 0 & 0 \\ 0 & G2 & P3 & 0 & 0 & 0 \\ 0 & 0 & G3 & P4 & 0 & 0 \\ 0 & 0 & 0 & G4 & 0 & 0 \\ 0 & 0 & 0 & 0 & Sa & Sa \end{matrix}$$

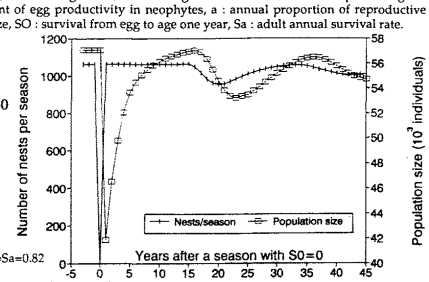

Fig. 2. - Simulation.
age 20 years, S1=0.70, S2=S3=0.81, S4=Sa=0.82

Sensitivity analysis. We first considered a theoretical population that is stable, stationary and non-exploited. The relative contribution of each matrix element (elasticity) to the **population growth** rate (λ) allows us to rank the importance of these **different demographic elements. Fecundity** is the element with the weakest contribution to λ, its **participation varies** from 5.7 to 2.2 %. The adult survival has a contribution which varies from **14.4 to 48 %, the remainder being** due to growth of the young. We can illustrate the **weak importance** of fecundity by an example. For the Zakynthos subpopulation (1061 nests in 1984, STPS 1989), the simulation of one season with a fecundity equal to zero (S0=0) shows that the consequences are limited (Fig. 2).

The exploitation of a stage by fishing corresponds to an increase in the natural mortality (or a decrease in the survival rate). According to the stage considered, the disappearance of an additional individual doesn't have the same impact on the population. That impact is a function of the number of individuals in the stage and of the elasticity of λ with respect to the survival rate. The demographic structure of the model population (stable stage distribution) is given by the right eigenvector w of the matrix. Thus one can obtain the theoretical size of each stage. In the Mediterranean, we can consider that only individuals of size superior to 32 cm (SCCL) are retained (accidentally) by present fishing techniques. Stage Y2 is captured especially by the Spanish long lines, in the Balearic islands (Greenpeace, 1991) and in smaller amount in France (LAURENT, 1991), stage Y3 is captured in Italy (ARGANO, personal comm.), in Tunisia (LAURENT, unpuplished) and Malta (GRAMENTZ, personal comm.). Stage Y4 and the two stages of nesting females are especially taken in the east Mediterranean by trawling (LAURENT *et al.*, 1990, MARGARITOULIS *et al.*, 1991). These three last stages form the stage of individuals with a size equal or superior to 70 cm (SCCL), called stage 70. Sensitivity analysis makes it possible to measure the importance for the population of an individual from different stages. An individual of stage 70 is 75 to 654 times as important as an egg, 7.6 to 26.3 times as important as an individual of stage Y2 and 3.2 to 4.3 times as important as an individual of stage Y3.

Application for the conservation of the Loggerhead in the Mediterranean. Because of perturbation by fishing, reduction of the natural or anthropogenic mortality of eggs should be continued but that measure is not sufficient to assure the survival of the species. A better strategy would be to orient action to protection of the adults as a first priority. In practice of course it would be easier simply to protect stage 70. It is therefore necessary to take a census of all fishing techniques that capture individuals of this stage in order to identify and apply specific measures of protection, especially in the eastern Mediterranean. We have no information on trawling in Libya or Egypt. At laying sites, all adult mortality of human origin should be stopped, in particular boats or coastal fishing should not be allowed near nesting beaches.

Acknowledgements

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Length distribution and total mortality rate Z of *Merluccius merluccius, Mullus barbatus* and *Eledone cirrhosa* exploited by the trawling fleet in 1982 and 1991 off the Catalan Coast (NW Mediterranean)

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Hake (*Merluccius merluccius*), striped mullet (*Mullus barbatus*) and white octopus (*Eledone cirrhosa*) are three of the main target species of the trawling fleet off the Catalan Coast. During the last ten years, catches have remained at a similar level. Hake catch was around 1800 tons during the period June 1982- May 1983, and 2400 tons in 1991; the striped mullet catch has been the same during all this period, about 700 tons per year; and the octopus catch (*Eledone cirrhosa* and *Octopus vulgaris*) was 1500 tons at the beginning of the period, and 1100 tons in 1991 (MARTIN, 1991; SANCHEZ & PDPEM, 1991).

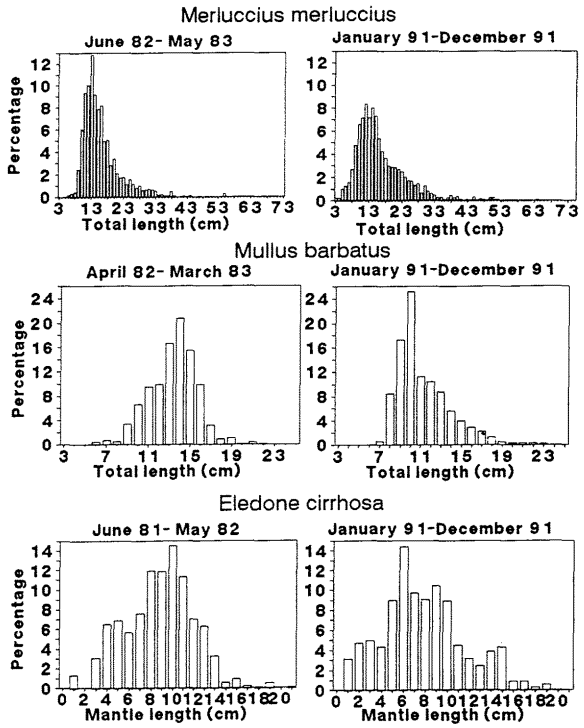
The range of exploited sizes has not changed significatively since 1981 in the three species (Figure 1). The mean length of catches has been the same in the case of hake (16.2 and 16.8 cm) and octopus (8.9 and 7.9 cm mantle length), while that corresponding to the striped mullet has decreased (from 13.4 cm to 11.3 cm).

	Merluccius merluccius		Mullus barbatus		Eledone cirrhosa	
	1982	1991	1982	1991	1982	1991
l min.	5.0	3.0	6.0	6.0	1.0	1.0
l mean	16.2	16.8	13.4	11.3	8.9	7.9
l max.	68.0	73.0	22.0	23.0	21.0	20.0
l'	13.0	12.0	14.0	10.0	10.0	6.0
lm	18.3	19.4	15.1	12.2	11.7	9.5
Z*	0.785	0.558	1.150	0.7		
Z**	0.435	0.377	0.694	0.469		
Catch (Ton)	1799.4	2386.5	674.8	694.8	1474.2	1118.3

l' smallest length fully recruited
lm mean length estimated from l'

The smallest length fully represented in the catch samples (l'), in the three species, is very close to the mean length of the catch, which indicates that the exploitation is driven mainly towards the smallest lengths (class 0 and 1 in the hake and striped mullet, and recruits of the year in the white octopus).

During the period from 1982 to 1991, the fishing effort has undergone slight variations (466 vessels in 1982, 430 vessels in 1991). With respect to catches, these have remained at a similar level, which seems to indicate that an equilibrium in the exploitation has been achieved, centered mainly in the recruits (overexploitation of the recruitment).



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Diagnosis of Chaos in a pelagic Ecosystem

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In order to achieve a "substainable development" is very important to manage natural resources. For an efficient management of the marine environmental, it's necessary to know the state of resources, their biology and how they interact with the environment. There is some experimental evidence that the abundance of the small pelagics, in a given marine area, shows strong time fluctuations and is, year by year, unpredictable. Several theoretical studies (MAY, 1976; MAY *et al.*, 1979) demonstrated that the growth of some biological populations can exhibit a wide range of dynamical behaviours, from stable equilibrium points, to stable cycles with several points, through to a chaotic regime.

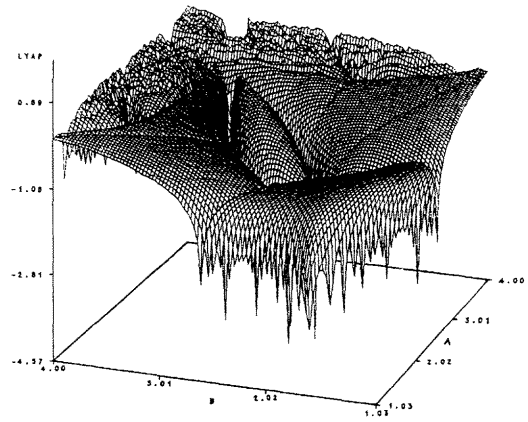
The dynamical behaviour of a population in chaotic regime makes unpredictable the amount of the biomass in a certain time. This problem makes the population dynamics models, useless for resources management purposes, particularly for the small pelagics. The diagnosis of the dynamical behaviour of pelagic ecosystem can be very useful to reduce management errors.

The aim of this paper is to describe a method for characterizing the turbulence in a biological population.

The figure shows a mapping of turbulence in a biological system obtained computing the Lyapunov exponent for a couple of values -a and -b representing the population fecundity parameter in the logistic equation. In this example it's possible to observe, to the top side of the plot (right and left), the typical structure of turbulence. The analisys of this maps allows to get usefull informations for practical applications.

The classical method utilized to diagnose the turbulence have some limitation, because, 1) needs a high number of input points for the mathematical convergency and 2) shows only the presence or absence of the chaos but not the intermediate levels (OLSEN *et al.*, 1985). The first problem affects the possibility to apply in the future this method to the natural populations, in which the amount of the measures is often low, specially in the marine environment, where the data sampling is very expensive. The second problem limits the amount of the information and it doesn't allow a thicher characterization.

Our method is based on the classical turbulence theory of KOLMOGOROV (KOLMOGOROV, 1941). For testing our method we have simulated the dynamic behaviour of a biological population by means a simple model namely the simplest of all non linear population models - the discrete generation logistic growth equation. Given a particular iterate it's possible to obtain its position in the "Kolmogorov spectrum". Our results demonstrate how is possible to overcome the limits of classical methods.



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V

Biology of Red Mullet *Mullus surmuletus* on Majorca Island waters

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Red mullet is mainly fished in the Southern part of Majorca Island between 25 and 50 m deep. The total Island catch varies yearly, the minimum registered was 132 t on 1970 and the maximum 400 t on 1961. In recent years the catches have oscilated around 200 t (213 t on 1989). As a part of the Island fishery study carried out by the Centre Oceanografic de Baleares (IEO), the biology of red mullet was studied on 1989.

The length, weight, sex, maturity and age of 1092 red mullet were determined. The length range of the studied fish was comprised between 10 and 27 cm total length.

The catches were composed mainly by females, small inmature fish appeared in early fall (figure 1). First maturing fish were 11 cm in length, while 50 % of maturity was reached at 15 cm by the females and at 17 cm by the males. The spawning season was limited to April-May.

The length-weight relationship determined is as follows :

	a	b	r
males	0.031742	2.66867	0.9591
females	0.016003	2.91282	0.9717
total	0.016003	2.91282	0.9748

The otoliths showed a concentric pattern of rings with abundant false rings. The evolution along the year of the opaque rings in the otolith margin (figure 2) showed the formation of a ring per year. Once the annual periodicity of the rings was validated, the agelenth key was determined using 1st July as birthdate. The fishes were from age Class 0 to age Class IV. The von Bertlanffy growth parameters were determined by means of FISHPARM programme. The values of the von Bertalanffy parameters were:

	L_∞ cm	K	t_0	W_∞ g
population	29.76	0.2376	-2.0649	310.74
males	23.39	0.2882	-3.3250	137.32
females	34.53	0.1364	-3.8210	505.75

The females showed a higher maximumlength, while males had a bigger growth rate. These values are higher than the growth parameters reported from other Spanish areas (MORALES-NIN, 1986), probably due to the small age range present in the fishery.

Due to the bathymetric distribution of red mullet, the bigger (and older) fish are not available to the fishery and appear occasionally in the fishery directed to hake.

Figure 1.- Monthly proportion of males (Black bar), females (stripped bar) and indetermined fish (dotted bar).

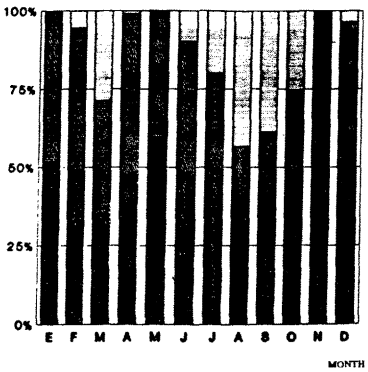
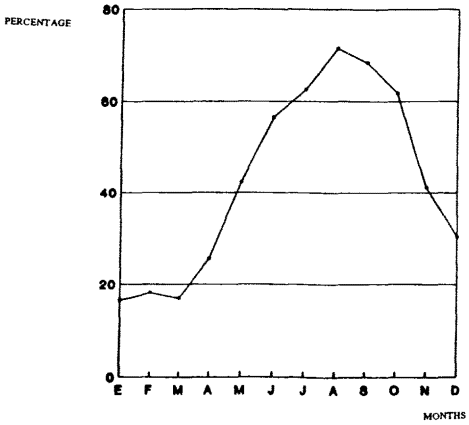


Figure 2.- Proportion of otoliths with an opaque ring in the edge.



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Dolphin-Fish *Coryphaena hippurus* (Linnaeus, 1758) biology and fishery in Majorca Island (NW Mediterranean)

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Dolphin-fish is an oceanic epipelagic species, distributed worldwide in tropical and subtropical waters (PALKO *et al.*, 1982) and limited by the 20°C isotherm (GIBBS & COLLETE, 1959). It is found in the Mediterranean, where is captured occasionally on the littoral areas. However, dolphin-fish is the objective of a fishery on Malta (GALEA, 1961), Tunisia (J. ZAOUALI, com. pers.) and Mallorca (MASSUTI & MORALES-NIN, 1991). The fishing methods employed are very similar and based on the agregatory behaviour of the species under floating devices.

Dolphin-fish is found off Majorca Island from spring to fall. On 1990, the fish appeared on May when the surface water temperature was 18°C, and disappeared in December when the surface water temperature was 16-17°C. During this time this resource was exploited by two different fisheries :

*Adult dolphin-fish are caught as a by-catch of the *Xiphias gladius* fishery using drifting loglines. The length range of the fishes captured from May to November 1990 (N=62) was from 60 to 117 cm fork length.

*From the second fortnight of August to the first days of December, the juvenile fish are caught by an artisanal and traditional fishery based in his agregatory behaviour under floating devices. The floats are moored in waters from 70 to 500 m deep and mainly at 7 to 11 miles off the coast. The floats are visited daily at sunrise and dawn. The presence of fish under the floats are detected visually and with trolling line, and then fishermen deploy an special surroinding net without purse line around the float. In 1990, 48 fishing boats (the 12% of the artisanal fleet) were directed to this fishery. The catches (96.6 tons) represented the 3.9% of the total annual catch registered in the Majorca Central Fish Market and the 3.10% of his value. However, 30-40% of the fish is sold outside the marked, making the real catch much more important.

Age was determined by means of scale interpretation (N=52). Four age classes were found, recruits of age 0 with a fork length range comprised between 19 to 70 cm, age 1 with a length range comprised between 62 and 101 cm , age 2 corresponding to 78 to 115 cm, and age 3 with a length range comprised between 95 and 118 cm. The von Bertalanffy growth parameters determined were :

$$L_\infty = 97.22 \text{ cm}, W_\infty = 8509 \text{ g}, K = 1.92, t_0 = 0.04$$

Recruit fishes growth actively during their exploitation phase. The mean monthly length of the fishes sampled on 1990 (N=2635) doubled on the studied period (Table I).

On 1990, the gonadosomatic index in adult female fishes showed that the spawning period started on June and continued until August (Table II). To determine the birth date of the recruits, a small sample of otholits (N=14) was studied. The fish age was determined by means of daily growth increments and the corresponding birthdates were backcalculated from the date of capture. The growth increments found in dolphin-fish otoliths are laid down with daily periodicity (UCHIYAMA *et al.*, 1986), allowing to determine the age in days with great precision. The analysis of the studied otoliths showed that the birth date period was from June to September with a maximum in July (Table II). This data are in accordance with the maturity stages in adult fish and suggest the presence of a spawning area near Majorca Island.

Table I: Recruit fishes growth during his exploitation on 1990 (Fork Length in cm).

	Aug	Sep	Oct	Nov	Dec
N	389	922	404	904	16
Range	21-34	23-52	28-58	37-70	43-56
x	24.1	35.3	40.7	46.0	48.9
S	2.1	5.1	4.6	4.2	3.8

Table II: Gonadosomatic index (G.S.I.) in adult female fishes and percentages of recruit birthdates on 1990.

	May	Jun	Jul	Aug	Sep	Oct	Nov
G.S.I.	2.6	11.3	9.2	8.9	---	5.0	0.9
% Birthdates	---	7.1	57.1	28.6	7.1	---	---

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V

Cetaceans in the Northern Adriatic Sea : past, present and future

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The regular cetacean fauna of the Northern Adriatic Sea, currently represented by a single dolphin species, the bottlenose dolphin (*Tursiops truncatus*), is notably reduced with respect to the Mediterranean Sea, where the number of cetacean species regularly occurring is already reduced in comparison to most Atlantic regions (NOTARBARTOLO DI SCIARA, 1992).

By contrast, a review of the scientific literature reveals that, in addition to bottlenose dolphins (GIGLIOLI, 1880; TROIS, 1894; NINNI, 1901; VATOVA, 1932; DULIC and TORTIC, 1960; PILLERI and GIHR, 1977), the cetacean fauna of the Northern Adriatic Sea is composed by a greater number of species, including: a) deep water cetaceans such as fin whales, *Balaenoptera physalus* (CAPELLINI, 1877; TROIS, 1894; NINNI, 1901; DULIC and TORTIC, 1960; PILLERI and GIHR, 1977), sperm whales, *Physeter catodon* (NARDO, 1853; TROIS, 1894; NINNI, 1901; DULIC and TORTIC, 1960), false killer whales, *Pseudorca crassidens* (NOTARBARTOLO di SCIARA, 1992), pilot whales, *Globicephala melas* (HIRTZ, 1922; DULIC and TORTIC, 1960), Risso's dolphins, *Grampus griseus* (GIGLIOLI, 1880; TROIS, 1894; VALLE, 1900; NINNI, 1901; DULIC and TORTIC, 1960) and common dolphins, *Delphinus delphis* (NARDO, 1853; TROIS, 1894; NINNI, 1901; VATOVA, 1932; DULIC and TORTIC, 1960; PILLERI and GIHR, 1977); and b) species now known or presumed to have been misidentified, such as blue whales, *Balaenoptera musculus* (DULIC and TORTIC, 1960), minke whales, *B. acutorostrata* (RALLO, 1979), white-beaked dolphins, *Lagenorhynchus albirostris* (DATHE, 1972), and harbour porpoises, *Phocoena phocoena* (NARDO, 1853; RALLO, 1979). In addition, striped dolphins (*Stenella coeruleoalba*), which have recently become the commonest pelagic cetaceans thoughout the Mediterranean, occasionally stray into the area and stand along the Italian shores (CENTRO STUDI CETACEI, 1990).

A critical analysis of all these reports, however, suggests that the occurrence of most of these deep-water species must be considered an exceptional event in the Northern Adriatic Sea. Until recently only two cetaceans were regularly seen in this region: the common dolphin and the bottlenose dolphin (VATOVA, 1932; PILLERI and GIHR, 1977). In the past decade, however, unknown reasons caused common dolphins to almost completely disappear from all the seas surrounding the Italian peninsula and islands, including the Northern Adriatic (NOTARBARTOLO di SCIARA, 1992), leaving bottlenose dolphins the sole cetacean species resident in the area (NOTARBARTOLO di SCIARA *et al.*, 1990).

A sighting of a group of four adult common dolphins, made by us in the waters adjacent to the island Losinj (44° 33' N, 014° 30' E) on 2 August 1991, was therefore rather surprising.

The low cetacean diversity of the Northern Adriatic Sea certainly reflects the peculiar environmental conditions of this region (shallowness and extreme ranges of physical-chemical properties), which also correspond to the habitat requirements of bottlenose dolphins, but might also be influenced by the negative effects of human activities. Are cetaceans going to disappear entirely from this part of the Mediterranean? Reports exist concerning the general unhealthy condition of bottlenose dolphins found on the Italian side of the Adriatic (GREENWOOD and TAYLOR, 1978), although recent field studies on the Croatian side point to the opposite (BEARZI *et al.*, in press). Dolphins are long-lived top predators, and as such are excellent bioaccumulators of xenobiotic, potentially noxious substances. A monitoring of bottlenose dolphin populations trends and ecology in this region is thus important not only to enhance our understanding of the general ecological mechanisms regulating this delicate marine environment, but also for the conservation of the last existing cetacean in the Northern Adriatic Sea.

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Analysis of the fluctuations observed on the landings of the trawling fleet of the Balearic Islands

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A research project on hake (*Merluccius merluccius* L.) and red mullet (*Mullus surmuletus* L.) fisheries has been carried out in Balearic Islands since 1977 and on red shrimp (*Aristeus antennatus* R.) since 1991.

Series of commercial landings [1] (Fig. 1: hake, red mullet and red shrimp) for the period 1940-1991 are also available. These have been studied by ASTUDILLO and CADDY (1986), putting in evidence the fact that fluctuations in the annual landings exists.

Furthermore the dynamic of the popultion of hake in the period 1980-1986 has been analyzed by means of a virtual population analysis (OLIVER, 1990).

Considering these informations, we can observe in first place a negative corre-lation between the hake and red mullet series of annual landings, presenting an approximate period of 12 and 15 years respec-tively. The red shrimp landings also present a periodicity, but with a shorter interval of a 6-8 year period, observed by other authors (TOBAR and SARDA, 1987). (Fig. 1).

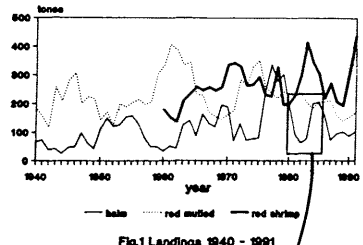

Fig.1 Landings 1940 - 1991
Balearic Islands

The fishing grounds ha-ve extended progressively during the period conside-red between (1940-1991), from the coastal fisheries towards the continental shelf, were red mullet can be considered as the target species, throught deeper fishing grounds, where the target species might be the hake, and finally reaching the deeper slope fishing grounds where the red shrimp is captured.

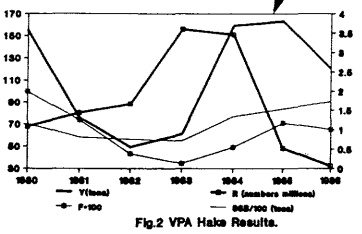

Fig.2 VPA Hake Results.

The results of VPA show a delay of one year, in its fluctuation, of yields (Y), in relation to the ones of recruitment (R), may be caused by the incorporation of the recruits, belonging to age class I, born the year before.

That way the maximum recruitment (age class 0) observed in 1983 is followed by a maximum yield in 1984. (Fig. 2).

In the same way a decreasing fishing mortality (F) can be observed until 1983, possibly due to the progressive lack of interest of the fleet towards the hake, due to the missing catches. This could lead us to think that in certain periods the efforts could be directed in an alternative and major way towards one or another species, depending on the level of catches obtained at that moment. In any case, as it has been shown by other authors (ASTUDILLO and CADDY, 1986), the periodical fluctuations of the landings would be independent of the fishing efforts.

At the same time there is a relative stability of the Spawning Stock Biomass (SSB) observed, anyhow sensible, with a major imbalance towards the fluctuations of the recruitment. This stable minimum level of SSB make the occasional appearance of the rich recruitments possible, which allow the maintainment of the fisheries.

[1] Source of data: Anuarios de Pesca (Estadistica Pesca Oficial) 1940-1969, I.E.O. data 1970-1990.

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V

Etat d'exploration du Merlu (*Merluccius merluccius* L.) et du Rouget (*Mullus surmuletus* L.) des Iles Baléares

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Le merlu et le rouget sont deux espèces cibles de la pêche chalutière des îles Baléares. Depuis 1980 nous avons réalisé mensuellement des échantillonnages biologiques et biométriques sur les débarquements. Les courbes de croissance des deux espèces ont été établies à partir de la lecture des otolithes (OLIVER *et al.*, 1990; OLIVER, 1991 et MORALES-NIN, 1991). D'autres aspects de la biologie de ces espèces ont été également étudiés. Ceci a permis en particulier d'établir la structure démographique des deux espèces pour la période 1980-1991. A partir de ces données nous avons effectué une étude préliminaire de la dynamique des deux populations exploitées par la pêche, au moyen des méthodes des pseudocohortes (démographie moyenne 1980-91), des populations virtuelles (VPA) et du rendement par recrue (Y/R). Les calculs ont été réalisés au moyen du programme VIT (LLEONART et SALAT, 1992). Pour le rouget, les paramètres biologiques employés dans l'analyse (Tab.1) ont été complétés avec ceux obtenus par ANDALORO *et al.* (1985). Le tableau 2 présente les résultats de la VPA et le tableau 3 ceux de Y/R. La VPA situe les recrutements annuels moyens autour de 1750000 individus pour le merlu et de 3900000 individus pour le rouget. Dans les deux cas, les vecteurs de mortalité par pêche (F) montrent que les populations supportent des taux de mortalité élevés à partir de la première classe d'âge. Ceci traduit une situation de surexploitation importante, situation classique dans les pêcheries démersales méditerranéennes au chalut. L'analyse du rendement par recrue confirme cette situation. Les résultats montrent qu'en réduisant l'effort de pêche on obtiendrait pour les deux espèces des améliorations significatives de Y/R et des biomasses (SSB et biomasses totales). Ces améliorations pourraient être obtenues en combinant une diminution d'effort avec une protection des juvéniles. En conclusion, toute mesure de régulation de l'activité halieutique, tant au niveau de l'effort de pêche que du schéma d'exploitation, permettrait de rationaliser l'exploitation de ces populations tout en améliorant leur état de conservation.

	MERLU	ROUGET
Croissance	L_{∞}=94.24 k=0.086 t_0=-0.59	L_{∞}=29.75 k=0.49 t_0=-0.31
Taille-poids	a = 0.0043 b = 3.15	a = 0.0093 b = 3.07
Age 1ere mat 50%	L_m = 32.7	L_m = 15.0
Mortalité	M = 0.15 F_t = 0.50	M = 0.20 F_t = 0.50

Tableau 1. Paramètres biologiques.

MERLU		Données globales			Résultats de la VPA		
Classe	Ages	Taille	No.	Poids	No.	Z	F
1	0.487	8.312	5744	23838	1761044	0.154	0.004
2	1.453	15.160	481344	11451680	1152527	0.568	0.418
3	2.406	21.387	507818	34589840	509434	1.147	0.997
4	3.422	27.479	140551	20857180	175500	0.951	0.801
5	4.419	32.967	55827	14628820	66842	0.985	0.835
6	5.418	38.009	21123	8644630	24776	1.003	0.853
7	6.421	42.657	7512	4414962	9245	0.962	0.812
8	7.428	46.938	2645	2098919	3673	0.870	0.720
9	8.442	50.885	918	938944	1653	0.705	0.555
10	9.430	54.419	535	676290	767	0.848	0.698
11	10.440	57.730	201	305114	346	0.730	0.580
12	11.432	60.715	109	193804	160	0.831	0.681
13	12.328	63.205	85	172267	41	2.226	2.076
14	14.538	68.376	9	22587	17	0.650	0.500
		TOTAL=0.122E+07		.990E+08	.358E+07		
			Capture	Age moy:2.33	Taille moy:20.63		
			Stock	Age moy:1.35	Taille moy:14.15		

ROUGET		Données globales			Résultats de la VPA		
Classe	Ages	Taille	No.	Poids	No.	Z	F
1	0.472	9.264	466272	5243450	3874696	0.342	0.142
2	1.334	16.353	2200222	112303000	1135832	2.137	1.937
3	2.318	21.481	269942	31049310	123798	2.381	2.181
4	3.396	24.865	18372	3296315	16893	1.288	1.088
5	4.442	26.823	2977	673161	5963	0.699	0.499
6	5.442	27.957	1484	380929	2961	0.701	0.501
7	6.310	28.581	1728	474483	747	2.513	2.313
8	8.429	29.263	118	34905	236	0.700	0.500
		TOTAL=0.296E+07		.153E+09	.457E+07		
			Capture	Age moy:1.31	Taille moy:15.78		
			Stock	Age moy:0.76	Taille moy:11.45		

Tableau 2. Données initiales de capture et résultats de la VPA.

MERLU				ROUGET			
Biomasse vierge = 0.105958E+11				Biomasse vierge = 0.329746E+10			
F	Y/R	B	SSB	F	Y/R	B	SSB
0	0	6016.8	5896.7	0	0	851.0	830.2
F0.1(0.10)	168.75	2149.4	2043.4	F0.1(0.16)	55.29	279.0	260.3
Fmax(0.14)	172.78	1700.0	1597.5	Fmax(0.26)	58.05	176.6	156.8
Fact(1.00)	56.23	76.4	29.9	Fact(1.00)	39.61	29.6	16.6
2	32.70	28.0	2.3	2	29.19	15.5	5.4

Tableau 3. Résultats de l'analyse de rendement par recrue.

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V

Some aspects of biology and population dynamics of the Fork-Beard (*Phycis blennoides*) from the N. Aegean Sea

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The fork-beard is a demersal fish occurring on the continental shelf of the Mediterranean Sea and N.E. Atlantic from Iceland, Norway and Kattegat to Morocco (WHITEHEAD *et al.*, 1986). Almost nothing is known about its life history and ecology (NONY, 1983). The fork-beard is of limited commercial importance in the greek seas. This study was undertaken in order to determine the age and length composition, to obtain growth estimates and to indicate some of the factors which determine its population structure.

Material and methods

The study was based on 850 fork-beards caught seasonally in the N. Aegean Sea from June 1990 to March 1991. Sampling was performed by a commercial bottom trawler of 500 HP, using a net with a cod-end mesh size of 14 mm from knot to knot. The duration of each trawl haul varied between 45 and 60 min. Total length to the nearest mm, body weight to the nearest g., sex and maturity, when possible, were recorded. Age determination was based on otolith readings. The procedure for making otolith sections ready to be read was to place them in cold mounting resin and cut them longitudinally through the nucleus with an electric law-speed saw.

Results and discussion

Total length ranged from 75-450 mm TL; the main part of the stock consisted of specimens with lengths between 145 and 275 mm. Young individuals 75-145 mm TL were mainly collected in the summer and early autumn. The young-of-the-year recruit in the N. Aegean Sea mainly in summer, exhibiting a smaller presence in the autumn catches (Fig.1). A shifting of the mode 115-145 mm towards greater lengths is obvious in early autumn, as well as in the following winter and spring; this shift possibly reflects fish growth during the first year of life, since the completion of the first annulus takes place in winter. The length frequency distribution suggests that the population consists of six year classes, but only the modes 175-195, 245-265 and 275-285 mm seem to represent individuals belonging to age groups I, II and III.

Back-calculated lengths at each age were estimated using the otolith radius/fish length regression derived by plotting the radius of the otolith section on total fish length. The correlation coefficient, and the standard error estimates justify the linear fit to the data. The relationship between TL (mm) and otolith radius (R), obtained from 165 individuals was : TL=-35.0 + 5.8xR. The ~39.0% of the maximal size was attained at age I year, while a relatively slow reduction of growth rate occurred during the following years. The great difference between observed and back calculated lengths could be attributed to the fact that otolith measurements were made on fish collected in June, which had already completed at least a half-year increment.

Table I. Back-calculated TL in mm of fork-beard from the N.Aegean Sea.

Age group	Numbers of individuals	Length at capture	Calculated length at end of year I	II	III	IV	V	VI
1	79	203	155					
2	48	251	141	215				
3	28	292	144	210	262			
4	7	341	149	213	263	307		
5	2	398	157	233	279	317	349	
6	1	431	151	215	267	314	355	388
Mean back-calculated lengths			149	213	263	310	351	388
Pecentage of growth (%)			38.9	16.5	12.9	11.1	10.5	9.5

The growth parameters were obtained from calculeted lengths for all fish and were used to calculate the von Bertalanffy equation. The asymptotic length (L_{∞}) was found to be 658 mm and the growth coefficient (K) was 0.128 and t_0=-1.01. During the course of the survey a total of 293 specimens were weighed and the lenght-weight relationship was computed: $W = 0.000011 \times TL^{3.364}$, where W= weight in g., and TL=total length in mm.

Natural mortality (M= 0.26) of fork-beard was estimated according to Pauly's equation, using as mean yearly temperature T=13°C Total mortality (Z=0.84) was estimated according to the catch curve method (RICKER, 1975). Fishing mortality was (F) =0.58 and the exploitation rate was E=0.69.

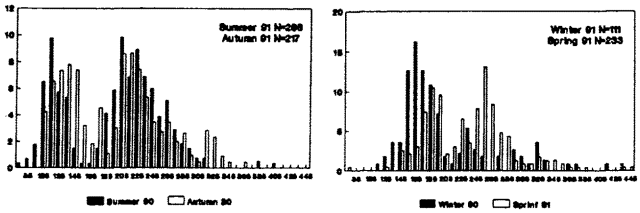

Fig. 1. Length composition of fork-beard in N. Aegean Sea.

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Stock assessments of Sprat (*Sprattus sprattus* L.) along Bulgarian Black Sea coast (1976-1990)

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The present ecological state of Black Sea and the sharp increase of sprat catches after 1976, are the two main anthropogenic factors, determining the significant variations in the sprat stocks off Bulgarian coast and in the whole western part of the basin. This stress the necessity of annual assessments of its biomass, aimed at tacing proper measures for rational exploitation.

Materials and Methods

Sprat biomass during 1976-1990 was calculated by GULLAND's variant of VPA (POPE, 1972). Relationship between catches and the mean weighed values of fishing mortality coefficient was estimated by the following equation :

(1) $Y = a.F_{2-4}.\exp(-b.F_{2-4})$

where : Y - catch in thousand tons ; F_{2-4} - mean weighed value of fishing mortality coefficient for full representative age groups.

Age composition of sprat catches is after IVANONV's data (1983, 1985, 1989, 1990).

Results and Discussion

It appears from Fig. 1 that the sprat biomass variation is from 167.5 to 204.6, avarage 179.8 thousand tons during 1976-1979. At the same period the sprat catches ammounted to 7.2-13.5, avarage 10.0 thousand tons, e.g. the sprat catches comprise from 4.07% (1976) to 8.08% (1979). However, sprat biomass decreased from 140.6 (1980) to 64.3 thousand tons (1982) during the following 3 years.

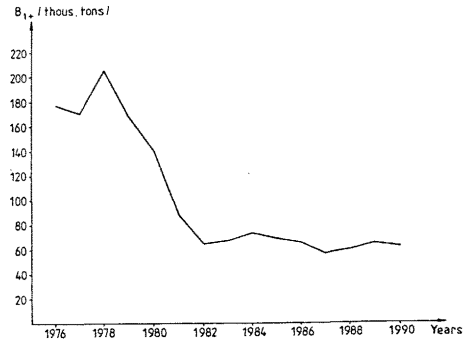

Fig. 1.- Sprat biomass (B1+.10³ tons) along Bulgarian Black Sea coast during 1976 - 1990.

After 1982 sprat biomass varies slightly from 56.8 (1987) to 73.7 (1984) thousand tons.

Largest sprat catches were recorded during 1980-1982, average 17.3 thousand tons.

For the period 1976-1985 the values of Y'msy and F'msy are 17.7 thousand tons and 0.437, respectively (Fig. 2). The last value is almost equal to this estimated by IVANOV (1984) and PRODANOV (1989)-0.435, thus differing significantly from this calculated by DOMASHENKO and YUREV (1978) - Fopt = 1.0.

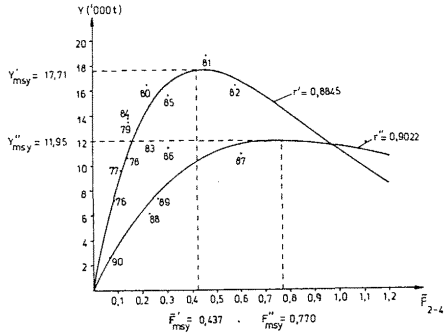

Fig .2.- Relationships between sprat catches and mean weighed values of fishing mortality coefficient during 1976 - 1985 (Y'msy; F'msy; r') and 1986 - 1990 (Y"msy; F"msy; r")

Antropogenic eutrophication of the basin after 1978 result in dramatic changes in plankton species composition, up to invasion of new species (*Mnemia mccradiy*), distinct increase in blooms both in time and space, leading to alteration in the whole food web (MONCHEVA, 1991; KONSULOV, 1991). Probably the decrease of Y"msy during 1986-1990 (see Fig. 2) can be related to *Mnemia maccradiy* expansion after 1986.

Conclusions

The present environmental state stress the necessity of preventive catch activities - in the next 2-3 years the sprat catches along Bulgarian Black Sea coast should not exceed 10.2 thousand tons ($Y_{0.1}$ = 0.85.Y"msy; Fmsy = 0.43).

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On a nesting of the loggerhead turtle (*Caretta caretta* L., 1758) along the Southern Coast of Sicily (Mediterranean Sea)

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Six species of marine turtles are reported from the Mediterranean Sea : *Caretta caretta, Chelonia mydas, Eretmochelys imbricata, Dermochelys coriacea, Lepidochelys kempii* (MARQUEZ, 1990) and *L. olivacea* (MAIGRET, 1986).

Among these, the loggerhead turtle *C. caretta* is the most common and it is known to reproduce all over the area (DELAUGERRE, 1987; MARQUEZ, 1990). It is also the only species which was reported to nest along the Sicilian coasts and the small islands near Sicily (BRUNO, 1986; DELAUGERRE, 1987;).

In this note some information is given about hatching of *C. caretta* that occurred on the beach of "Tonnarella", along the Gulf of Mazara del Vallo (southern coast of Sicily).

"Tonnarella" beach is about 6 Km long and it is limited by the harbor breakwater and by "Capo Feto" on its east and west sides respectively (see Fig.). The area hosts the summer residents of Mazara del Vallo, and the beach is lined by a large road with runs only a few tens of meters from the sea. A low wall separates the beach from the road.

Notwithstanding the indiscriminate parcelling out of the land (the whole area is amazingly crowded with buildings) the negative effect of human activities on the water quality was until now rather negligible, due to the strong currents off the Mazara coast and to the adoption of individual cesspools as aseptic system.

The nest was discovered on August 23 1990, during the morning when people on the beach noticed juveniles of *C. caretta* reaching the sea, while other specimens were lying dead a few meters from the water. About 30 cm in diameter and 50 cm deep, the nest was located close to the small wall which separates the beach from the road.

The authors, informed immediately of the event, recovered six live specimens and twelve dead ones. Those alive were brought to the sea, while the others were preserved in formalin. The preserved specimens are between 39 and 44 mm (SCL) long and weigh between 12 and 14 gr. From the shell fragments an estimate of the size of the eggs of about 30x50 mm was derived.

Our observations, together with the information obtained by people on the beach, indicate that the first hatching occurred during the night, and that the total number of eggs laid was about 50, which is in agreement with what reported in the literature (BRUNO, 1986; MARQUEZ, 1990).

This report confirms that the loggerhead turtle is a common species all throughout the Sicilian waters, as reported by local fishermen, and that it still reproduces along the Sicilian coasts, in spite of the environmental degradation and the human settlements which obviously constitute a disturbing factor.

The fact that this is the first documented nesting of the species on Mazara del Vallo shore since many years (at least since 1983 when our Insitute officially began to operate), can be due to several reasons. Among those depending on the situation on the land, there is the accidental non-disinfection of the beach (usually carried out during May) during spring 1990.

It also probable that the proximity of the wall limiting the beach protected the nest from an otherewise almost certain destruction : each year before summer in fact, the debris of seaweeds and seagrasses (mainly *Posidonia oceanica*) which pile up on the shore during winter are removed using mechanical tools, but this operation is usually performed manually close to the wall.

In any case this record is a quite positive indication of the adaptability of these animals to the changes made to the environment by human communities. It also suggests that we should consider the proposal to protect at least part of the shore (i.e., the beach beyond "Capo Feto"), as it was already decided for other sicilian areas (i.e., Lampedusa Island).

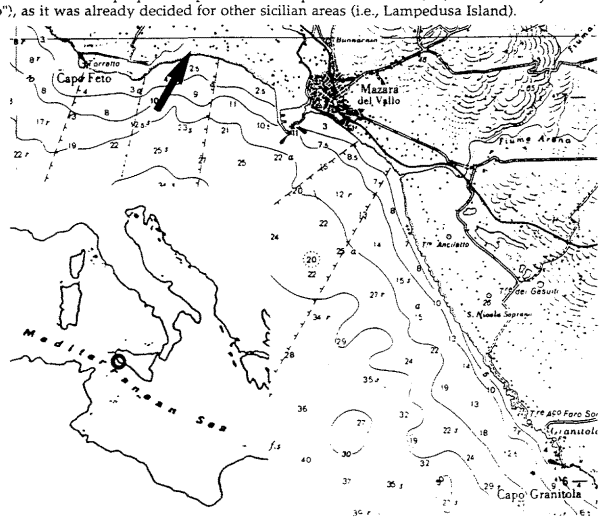

Fig. - The Gulf of Mazara del Vallo. "Tonnarella" beach is delimited by "Capo Feto" and the breakwater of the port. The arrow indicates the nest location.

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V

Occurence of the unihorn octopus *Scaergus unicirrhus* in the Sicilian Channel. II - Bathymetric distribution

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Very little is known about the vertical distribution of the unihorn octopus *Scaergus unicirrhus* Orbigny 1840, within the Mediterranean Sea (MANGOLD-WIRZ, 1963 ; SANCHEZ, 1986 ; MANGOLD & BOLETZKY, 1987), and information is particularly poor as regards the Sicilian Channel (JEREB & RAGONESE, 1990).

Although trophic and/or reproductive related vertical migrations are generally reported for octopuses, they have only been hypothesized for this species (Verany, in MANGOLD-WIRZ, 1963; ROPER *et al.*, 1984), as no direct evidence was available.

An attempt to indirectly validate this assumption of vertical migrations was made, using data collected during two years (May 1985 to February 1987) of seasonal, randomly stratified trawl surveys carried out within the Sicilian Channel (daily hauls of 1 hour duration ; cod-end mesh size- 20 mm/side ; see LEVI, 1990 for further details).

The analysis if the yield maps in numbers showed some seasonal variation in the distribution pattern of the unihorn octopus (dig.). Due to the geographical and seasonal constraints however, a correlation of this variation with a migratory habit was not clear.

The seasonal changes in the mean values of the catches in number (C), of the individual body weight (BW) as well as those of the mantle length (DML) and of the gonadosomatic indices (GW/BW) have been analyzed for different bathymetric strata (each stratum = 50 m.), for both sexes taken separately. A great variability was noticed and no cyclic pattern was identified, while only a slight correlation existed between the variables considered, which was almost never significant (at 95%) considering both the linear (Pearson coefficient : P) and the rank (Spearman coefficient : S) statistical approach utilized (see SOKAL & ROHLF, 1981, for statistical terminology). The gonadosomatic index in females and the numerical value of the catches in males appeared to be significatively correlated with depth (S = -0.428 and S = -0.445 respectively) only when both years were considered as a whole (i.e., combining seasonal data).

Basically, the abundance as well as the size variation and the maturity stages seem to be quite independent from bathymetry as well as from seasonal cycles.

Information on the physical-chemical characteristics of the water in the three main "sub-areas" explored (eastern, central and western, respectively) were also analyzed in relation to the species distribution. Although remarkably "adaptable" to different relatively "cold" (13-14 Ca) and "salty" (S > 38%) waters definitely below the upper limit of the thermocline, which is situated around 50 m depth. In fact only one specimen was caught above this limit, at 46 m depth. These results tend to support a relative sedentary life-style for this species as well as a great adaptability, as already observed in other areas (PERES & PICARD, 1964), confirming also MANGOLD's opinion (MANGOLD-WIRZ, 1963) that *S. unicirrhus* is unlikely to undergo substantial migrations.

The observed distibutional variations in the present case are more likely to be related to the sampling "noise" and to the multispecific aims of the research program.

Taking into consideration the observed difficulties in the sampling procedures and the problems related to the "interpretation" only mark and recapture experiments would give a satisfactory answer about the existence of a migratory behavior for *Scaerqus unicirrhus*.

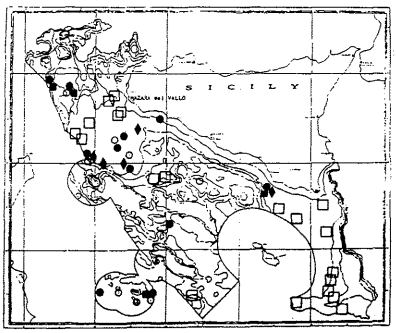

Fig. - Occurence of *S.unicirrhus* in the different seasons.

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On the association of the unihorn octopus *Scaeurgus unicirrhus* with white corals (Anthozoa-Madreporaria) in the Sicilian Channel

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The madreporarian formations (also know as the "white coral") which characterize some bathyal bottoms of the Mediterranean basin (PERES & PICARD, 1964) have been implicity looked at as a possible habitat for the productive activity of some bathyal cephalopods (MANGOLD-WIRZ, 1963). Among them is the unihorn octopus *Scaeurgus unicirrhus* Orbigny, 1840, whose vertical distribution goes from shallow waters to 800 m depth (MANGOLD-WIRZ, 1963; SANCHEZ & ALVAREZ, 1988).

Data collected during two years (May 1985 to February 1987) of seasonal, randomly stratified trawl surveys carried out in the Sicilian Channel (daily hauls of 1 hour duration; cod-end mesh size 20 mm/side; see LEVI, 1990 for further details), evidenced a wider distribution and a greater abundance of this species within the area investigated than previously believed.

Information from the literature (BOURGOIS & FARINA, 1961 and others) as well as from the local fishermen, indicate that the white coral formations are quite common and rather wide-spread within the Sicilian Channel.

In this context it seemed interesting to investigate the association of the unihorn octopus with the madrepore reefs (mainly *Madrepora oculata* and *Lophelia pertusa*), which seemed to be supported by direct as well as indirect evidence.

As direct evidence, data collected showed :

a) - *S. unicirrhus* catches were more abundant on rough bottoms, where the hauls could not be repeated;

b) - shelf borders, continental slopes and slopes of submerged mounts ("guyots") seem to be the preferred habitat both for the unihorn octopus and the madrepores ;

c) - females in advanced maturity stages (i.e., with "large" but still "striated" eggs of about 2-2.5 mm length in the ovary) were frequently observed (pers. obs.), but only 6 specimens of the 206 examined carried some "smooth" eggs, indicating a fully mature condition (MANGOLD-WIRZ, 1963);

d) - the percentage of females in the catches decreased linearly (from 70% to -0) with the increasing size of the specimens which, together with point c), suggests a decreasing probability of mature females to be captured;

e) - an attempt of cluster-analysis among some specific "biocenosis indicators" showed a relation between *S. unicirrhus* and *Cidaris cidars*, an echinoderm closely associated with the white coral community (PERES & PICARD, 1964);

Among indirect evidence, the following information is presented :

a) - although eggs of this species were never recorded in nature, laboratory experiments indicate that females lay their eggs on hard substrata (BOLETZKY, 1984);

b) - juveniles are supposed to be planktonic but their occurrence in plankton samples is extremely rare (ROPER, 1977);

c) - newly hatches juveniles have 4 suckers on the arms instead of the 3 typical for other octopuses with a planktonic stage, and they can show very early the "sedentary" behavior of the adults.

These observations allow us to hypothesize on the following life cycle scheme (see also the Fig.):

1 - *Scaeurgus unicirrhus* mature females choose the madreporian reefs to spawn and subsequently care for the eggs;

2 - Once the young hatch, juveniles spend a moderately long period of time on the same bottom, where it is presumably easier to minimize predation pressure;

3 - sub-adult individuals spread over wider areas and different bottoms, where they continue to grow and approach sexual maturity.

Although other kinds of information are needed to confirm the above mentioned hypothesis (i.e., underwater films, experimental "bow-net" fishery on the "rough" bottoms), this is likely to explain the peculiar distribution observed for the unihorn octopus within the Sicilian Channel.

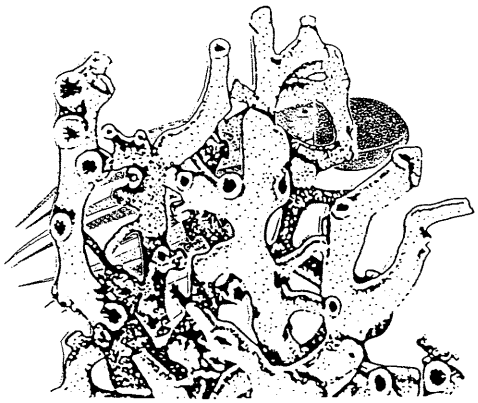

Fig.- An hypothetical reconstruction of the association of *S. unicirrhus* and madreporian reefs (*Lophelia pertusa*). Drawings are not to scale.

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V

Occurrence of the unihorn octopus *Scaergus unicirrhus* in the Sicilian Channel. I : Spatial distribution and abundance

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The unihorn octopus *Scaergus unicirrhus* Orbigny 1840, a by catch of the bottom trawl fishery in the Mediterranean, is much appreciated for its flesh quality and is regularly sold in the fish markets of Greece, Italy and Spain (MANGOLD & BOLETZKY, 1987).

At Mazara (one of the most important landing places of the Mediterranean) this octopus is well known as the so-called "polpo riccio" (curly octopus) and it is widely commercialized either alone or mixed with other valuable octopus species, namely *Octopus vulgaris*, *Eledone cirrhosa* and *E. moschata* (JEREB & RAGONESE, 1990; RAGONESE & JEREB, 1990).

Up to date species has been considered rather uncommon all through its main distributional area (MANGOLD & BOLETZKY, 1987, 1988 ; SANCHEZ & ALVAREZ, 1988) and little information is available for the central Mediterranean.

Data collected during two years (Spring 1985 to Winter 1987) of seasonal, randomly stratified trawl survey carried out within the Sicilian Channel (daily hauls of 1 hour duration; cod-end mesh size of 20 mm/side; see LEVI, 1990, research program TRAWL, for further details), were analyzed to give a description of the distribution of this species and information on its abundance.

The unihorn octopus occurred all over the area investigated (about 51000 square km; see fig.), showing a major concentration over the wide platform or "Banks" (the "Adventure" the "Terrible" and western side, respectively. The central portion of the area, characterized by a reduced continental shelf and sedimentation basin with canyons and valleys more than 800 m deep was poorly inhabited.

Caught between 46 and 776 m depth, the curly octopus seems to prefer a more restricted bathymetric range, being most abundant between 50 and 500 m. The only specimen caught above 50 m and the other 6 (in 4 hauls) caught beyond 500 m in fact, are likely to represent occasional captures, in agreement with that reported for the species in other Mediterranean areas (MANGOLD & BOLETZKY, 1987).

Catches were rather exiguous, considered both individually and as a whole (Tab.), with males dominant over females. Nevertheless it should be pointed out that the bottom trawl used is not selective for octopuses and that during the above mentioned TRAWL (a multispecific research program) daily hauls were taken, when octopuses are likely to be less vulnerable to fishery.

Moreover, a greater abundance was detected on some particularly rough bottoms, characterized by madreporian and barnacles formations, where the hauls were never repeated in order to save the net. Besides, local fishermen considerer this species quite common within the range of exploitation of the near shore trawl fishery.

Taking into account these considerations, our data indicate that *Scaergus unicirrhus* seems to be more common in the Sicilian Channel than previously believed and that its potential for a fishery seems greater than suspected.

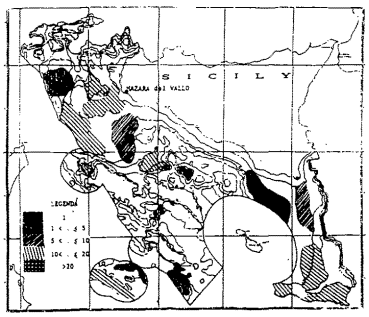

Fig.- Distribution (relative abundance in number) of *S. unicirrhus*.

TRAWL - SEASON	TH	HS.U.	TYm	TCm	MBWm	TYf	TCf	MBWf
1 - SPRING ' 85	55	23	11.6	123	95	3.3	41	80
2 - SUMMER ' 85	53	14	2.4	31	77	1.5	28	55
3 - FALL ' 85	57	17	2.9	45	64	1.2	29	40
4 - WINTER ' 86	58	15	3.3	52	63	2.1	32	65
5 - SPRING ' 86	63	18	4.0	48	83	1.4	29	47
6 - SUMMER ' 86	64	21	2.8	39	72	2.0	37	54
7 - FALL ' 86	71	23	7.1	91	78	2.7	46	59
8 - WINTER ' 87	69	22	4.7	73	64	2.8	49	58

Tab.- Total catch in weigth (TY, kg) and number (TC) and mean body weight (MBW; gr) for sex (m = males; f = females), and trawl season of *Scaergus unicirrhus* in the Sicilian Channell. TH = total number of valid haulus (1-800 m depth range), HS.U. = number of haulus where the species was caught.

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Estimation of mortality rates and critical age of *Helicolenus dactylopterus dactylopterus* (Pisces-Scorpaeniformes) in the Sicilian Channel (Central Mediterranean Sea)

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The bluemouth rockfish (*Helicolenus dactylopterus dactylopterus* Delaroche, 1809) is widely distributed throughout the Sicilian Channel, commonly inhabiting bottoms between 100 and 750 m, where it represents a frequent by-catch species for local trawl fisheries.

In this note, the authors report some estimates of the natural (M) and total (Z) mortality (per year), of the exploitation rate E = (Z-M)/Z, and of the critical age or age of maximum production (T_{mb}) i.e. the time in the life hystory of the population when the cohort is expected to maximize its biomass (ALVERSON & CARNEY, 1975).

In stock assessment and management, estimates of the rates of growth and mortality are basical inputs in order to evaluate the exploitation rates, as to have the minimum risk of a collapse of the whole population.

Data derive from a larger data-base gathered during a multispecies assessment program of the demersal resources in the Sicilian Channel (seasonally, from May 1985 to February 1987, experimental trawl surveys carried on by I.T.P.P.-C.N.R.; see LEVI, 1990 for further details).

We started from previously derived parameters of the Brodyvon Bertalanffy's growth curve: L_{inf} = 39.2 (TL; cm) K = 0.127 and t_o= -1.46 year (RAGONESE and REALE, in prep.);

An estimate of life span (T_{max} = 22 year) was derived according to TAYLOR (1958) with L_{max} = 0 95*L_{inf}.

Two estimates of M (0.20 and 0.31) were calculated according to HOENIG (1983) and PAULY (1979) respectively (in the second case assuming an average water temperature of 14°C).

A first estimate of total mortality rate (Z = 0.639) has been computed transforming the length frequency distributions, from four seasonal trawl surveys, in a length converted catch curve (Fig. 1a) according to PAULY's methodology (cfr. PAULY, 1984).

By regression of the logarithmic (natural; ln) of cumulative frequency (>= L_i) vs. ln (L_{inf} - L_i), i.e. the Jones and van Zalinge's method (in JONES, 1984)(Fig. 1b), the authors found out an estimate of the ratio Z/K = 5.009 and, multiplying for the above K value, a second estimate of Z = 0.636 consistent with the previous one and suggesting a value of Z = 0.64.

Natural mortality is a very critical parameter to be estimated (VETTER, 1988), but in this case the value of M = 0.31 seems more realistic considering that M = 0.2 is generally assumed for longlived species which reach the larger sizes in cold environments.

The resulting fishing mortality rate (F = 0.33) allows the derivation of an exploitation rate (E = 0.51) which is relatively high, supporting the hypothesis of a general overexploitation of demersal Mediterranean stocks (ANON, 1989).

From these data it has been possible to compute (ALVERSON and CARNEY, 1975; AULT & FOX, 1988) two different values of T_{mb}, 5 and 2 years for the unexploited (Z = M = 0.31) and the exploited (Z = 0.64) cohort, respectively.

The first estimate (T_{mb} = 5 years) sounds reasonable, considering that the bluemouth rockfish in the Mediterranean Sea, reaches sexual maturity at 3-4 years of age (BAUCHOT, 1987); the second estimate suggests that the resources is in growth overfishing.

Since the recruitment appears to be continuous enough (RAGONESE & REALE, in prep.), the management decision of delaying the age (size) of recruitment to the gear, e.g. widening the mesh size at the codend (20 mm of side, at present), could improve the status of the stock of the bluemouth rockfish in the Sicilian Channel.

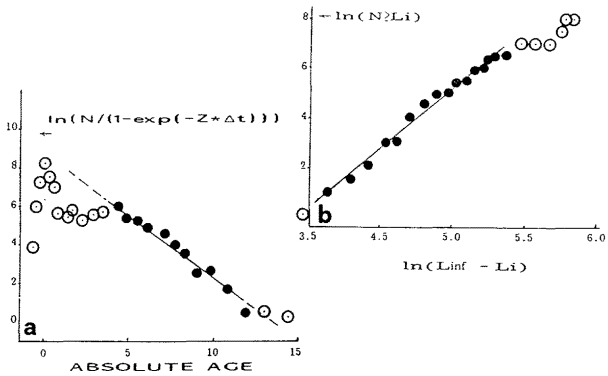

Fig. 1 - a) the length-converted catch curve for the bluemouth rockfish based on the growth data and M = 0.31; b) Jones and van Zalinge's plot. (●) used; (○) not used.

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V

New records of large neon flying squid (*Ommastrephes bartrami* Lesuer, 1821) in Southern Tyrrhenian Sea

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The status of flying squid populations (Cephalopoda, Ommastrephinae) in the Mediterranean sea is still unclear and needs systematic revision (MANGOLD & BOLETZKY, 1988).

To date, the orangeback (*Ommastrephes pteropus* Steenstrup, 1855) and neon-webbed squid (*O. bartrami*) can be quoted in Mediterranean check list us (CLARKE, 1966; ROPER *et al.*, 1984; MANGOLD & BOLETZKY, 1988) following the general agreement that the other previously recognized species (*O. caroli*) represented just the adult form of the latter species (ZUEV *et al.*, 1975; BELLO, 1986; NESIS, 1987).

O. bartrami is an oceanic, active swimmer, fast growing (Tmax=1-3 years), large sized (ML max =700 mm) squid with a circumglobal antitropical distribution (ROELEVELD, 1982; DUNNING & BRANDT, 1985).

In the adult, the presence of the enlarged ventral protective membrane in arm III (which might be characteristic of females; ROPER, pers. comm.) allows an immediate identification.

The first documented record in the Mediterranean Sea seems to be the floating dead specimen, reported as *Stenoteuthis bartrami*, observed at Banyuls sur Mer, France (LOZANO REY, 1905 in MORALES, 1958). In Italian waters, even though the occurrence of neon webbed flying squid has been reported for a long time (ISSEL, 1922 in CLARKE, 1966; BELLO, 1986 and others), its presence has been considered implicitly, sporadic and rare and often as a consequence of stray specimens.

Interwiews with sicilian fishermen (Central Mediterranean sea) who report about repeated occurrence of "huge" squid trawled or entangled, has led to the conviction that such a species could be more common than previously believed and the finding of a large landed specimen (RAGONESE & JEREB, 1990) has supported this assumption.

In this note, morphometric data and indexes (as a percentage of ML) relative to three new specimens (females) caught by "spadara" (ML= 597 mm), jigging (ML=525 mm) and coastal trammel net (ML=137 mm) respectively, in the Southern Tyrrhenian sea, are reported (Tab.).

The large females had spermatophoric residuals in the buccal pocket and showed scars on the antero-dorsal portion of the mantle which might be a consequence of mating (cf. MANGOLD, 1989).

The main difficulties in getting specimens of these large oceanic squid are due to the fact that no large scale jigging is operating in Italy (RAGONESE & BIANCHINI, 1990), no specific trammel net fishing is carried out in Italy up to date, and because swordfish and scomberoid drift nets (the so called "spadare") are characterized by relatively large mesh size. Moreover the misidentification of the young specimens of *O. bartrami* with the other, more common, *Todarodes sagittatus*, is very frequent.

In this context the records presented above together with other very recent reports (BIAGI, 1990) especially of young specimens (RELINI, 1990), support the opinion that a well established population does exist in the Tyrrhenian sea and, probably, in the whole Mediterranean Sea.

CODE	TL	TW(gr)	ML	MWI	FLI	FWI	HLI	HWI	EDI	TtLI	ALI I	ALI II	ALI III	ALI IV
A	1652	9412	613	39	44	77	21	22	9	146	50	64	60	61
B1	1563	7540	597	32	42	74	20	26	9	137	50	62	68	72
B2	1498	5260	525	37	43	71	27	22	8	165	59	71	74	70
C	387	185	137	/	45	32	24	20	6	137	40	46	52	61

Tab.- Morphometric data for the four specimens of *O. bartrami* (length in mm; indexes as percentage of ML according to ROPER & VOSS, 1983). "Code" indicates the source of specimens: squid caught by "spadara" (A; in RAGONESE & JEREB 1990), by jigging (B1-B2) and by a trammel net (C). Measurements on C made after fixation.

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Spreading of puffer *Sphoeroides cutaneus* Gunther, 1870 (Pisces, Tetraodontidae) in the Sicilian Channel. Is it an "exploding" population?

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Tetraodontidae, named puffers or swell-fishes after their ability to inflate the body, are circumtropical, littoral, medium sized fish present throughout the oceans (SHIPP, 1974).

Although some puffers are highly valued as a food delicacy, especially in Western Pacific (VIETMEYER, 1984), they can be deadly poisonous, due to their capacity to produce tetrodotoxin (HOAR & RANDALL, 1969).

Among the four species reported for the Mediterranean Sea *Ephippion guttiferum*, *Lagocephalus lagocephalus*, *L.spadiceus* and *Sphoeroides cutaneus* (FREDJ & MAURIN, 1987), the latter represents the most recent acquisition.

Recorded for the first time in the western basin (OLIVER, 1981), segnalations relative to the presence of this species followed one another, both in the western (e.g. CRESPO *et al.*, 1986) and in the central basin (e.g. VACCHI & CAU, 1986) of the Mediterranean ; up to date *S. cutaneus* is not reported, for the eastern basin (FREDJ & MAURIN, 1987).

As far as concerning the Sicilian Channel, Mazara trawl fishermen were interwieved in order to get informations about the occurrence and abundance of this puffer and to gather some specimens for morphological studies. Furthermore, data collected during experimental trawl surveys from spring 1985 (see LEVI, 1990 for details on the program) were consulted.

These informations allow us to give a picture of the situation:

a) mazarese fishermen know *S. cutaneus* and caught it frequently (50-250 m depth range) in the southern side of the Sicilian Channel;

b) more than 100 specimens were received by fishermen (just a small fraction of a larger but unknown total catch) ;

c) first catches occurred about 60 n.ml. north off Tripoli (n° 1 in Fig.) ;

d) further records are in agreement with a northward dispersal, also supported by experimental surveys (puffers began to occur in the catches only from spring '90 ; see Fig.).

Since this species is discarded by fishermen and the wide size-range observed (10-40 cm ; TL), it is likely that *S. cutaneus* in the Sicilian Channel is more abundant and earlier established than supposed on the base of literature available (VACCHI & CAU, 1986).

Present data support the introduction from Atlantic Ocean of the species which probably reached the Sicilian Channel following the southern north-east path current (Fig.).

Furthermore, the above picture might be the consequence of an "explosive" spreading of the species in the Central Mediterranean Sea, an hypothesis supported by recent records in Ligurian (FIORENTINO & ZANIBONI, 1990), Ionian (A. TURSI, pers. com.) and Adriatic Sea (C. PICCINETTI, pers. com.).

If the above picture and the "explosive" nature of spreading will be confirmed by further data, scientific and public communities must concern about the unforeseeable but worrying impact on the other demersal species and on the fisheries themselves since it is likely that more of the discarded puffers could survive.

Fig.- Records of *S. cutaneus* in the Mediterranean Sea (* ; 1 to 9 for the Sicilian Channel). Sources : 1 and 3 - interviews with mazarese fishermen ; 2 - VACCHI & CAU (1986) ; 5 and 9 - spring '90 (IX trawl) ; 4, 6 and 8 - fall '90 (XI trawl) ; 7 - summer '91 (XIV trawl). Arrows indicate the main currents patterns.

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V

L'Etat d'exploitation du Merlu (*Merluccius merluccius*) de la Mer Catalane (Nord Ouest Méditerranée)

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Le merlu (*Merluccius merluccius*) est l'espèce démersale la plus capturée dans la mer catalane (MARTIN, 1991). On a obtenu des fréquences de tailles de captures au chalut réalisées par differents ports de la côte catalane. On a calculé une fréquence de tailles annuelle totale qui a été adoucie pour faciliter les analyses (Fig. 1). La majeur partie de l'exploitation porte sur les individus très petits, au dessous de la taille minimum légale de capture (18 cm), et, si on considère les tailles de maturité du merlu, 32 cm pour les mâles et 39 cm pour les femelles (SANCHEZ et MARTIN, 1991), on constate que l'exploitation concerne essentiellement les individus juvéniles. A partir de cette fréquence de tailles et avec des paramètres biologiques on a fait des analyses de pseudocohortes des populations virtuelles (VPA) et de rendement par recrue (Y/R) avec le software VIT (LLEONART et SALAT, 1992). Les données biologiques que nous avons utilisé pour les analyses sont celles obtenues par le groupe de travail sur les pêcheries et la dynamique en Méditerranée de l'ICM de Barcelona (FARRUGIO *et al.*, 1991) et elles figurent dans le tableau 1.

Tableau 1. Paramètres biologiques du merlu.

Relation taille/poids ($Y = a*x^b$), a = 0.00564, b = 3.069
Mortalité naturelle (M) = 0.15
Mortalité par pêche terminale (Ft) = 0.15
Paramètres de croissance de l'équation de von Bertalanffy
$Lt = L\infty\ (1-e^{-K(t-to)})$, $L\infty$ = 110 cm, K = 0.11, t_o = 0.3 $anys^{-1}$

Le tableau 2 présente les résultats de la VPA. On a considéré comme recrutement les individus de la première classe de taille pêchée. La taille critique est celle qui correspond à la biomasse maximum en poids de la population en mer.

Tableau 2. Résultats de la VPA.

Recrutement en núm. ind.(*1000)	39965.2
Numéro moyen annuel (*1000)	47914
Recrutement en poids (R) (Kg)	3728.6
Biomasse moyenne annuelle (Kg)	3178400
Biomasse maximum (Kg)	446134.8
Bilan biomasse annuelle (D) (Kg)	2195000
Taille moyenne population (cm)	12.97
Taille critique (cm)	22.5

A l'équilibre, la biomasse au début d'une année (recrutement, R et croissance, C), est égale à la mortalité totale la même année (mortalité naturelle, M et par pêche, P). Si on rapporte cette augmentation de la biomasse dans la population exploitable (Tableau 3), on voit que R ne représente qu'une petite partie et que la biomasse qui arrive dans la pêcherie dépend en majorité de C. Ce diagramme d'exploitation nous montre que le merlu est une espèce fortement exploitée par pêche, et, comme il s'agit d'une espèce à vie longue, le stock n'est pas très influencé par le recrutement annuel.

Table 3. Relation entre les résultats de la VPA. Les valeurs sont en pourcentage.

Biomasse	Entrées		Sorties	
	R	C	M	P
Bilan (D)	0.2	99.8	21.7	78.3

La figure 2 représente la courbe d'evolution du rendement par recrue (Y/R). Les résultats donnent un Y/R actuel de 42.994 gr et un maximum de 97.64 pour un niveau d'effort de 0.3 par rapport à l'effort actuel. Ces résultats montrent que le stock de merlu parait actuellement surexploité et que l'on aurait interêt à diminuer l'effort de pêche afin de protéger la population.

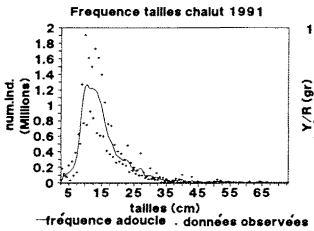

Fig. 1. Fréquence de tailles

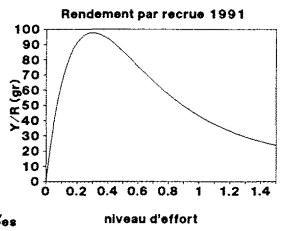

Fig. 2 Rendement par recrue

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Relation between Ichtyoplankton and geostrophic currents in the vicinity of the Straits of Gibraltar (S.W. Spain), in July 1991

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Analysis of the icthyoplankton abundance and general distribution in the zone, and especially that of the anchovy (*Engraulis encrasicolus*), in relation to the surface currents.

The main objective of the " Ictio. Alboran 0791" survey (5-18 July 1991) was the study of the possible influence that the dynamic regime has over the transport of fish eggs and larvae, particularly that of the anchovy, in the Alboran Sea.

The icthyoplankton samplings were carried out using a Bongo net with a 40 cm diameter opening fitted with flowmeters and a depthmeter and equipped with 250 and 335 micron meshes. The trawlings, double-oblique type, were carried out to a depth of 100 m.

A CTD "Seabird" system was employed to study the mass fields as well as reversing bottles fitted with thermometers.

In this paper we are going to focus on the study of the first 21 sampling stations. 9284 fish eggs and 5254 larvae were caught in those stations with a 335 micron mesh.

The Atlantic water which flows into the Strait of Gibraltar moves towards the East, as a jet, and part of this recirculates forming the permanent gyre of the Western Alboran Sea. This jet is the motive power for all dynamics of this sea and creates a thermohaline front on its way. This front is of great importance when separating zones according to their different features, and its position causes a different dynamic situation.

This flow was identified and showed that it runs almost straight towards the East, up to 4º 20' W. The most intense flow was found in sampling stations 14,15, 9 y 10 (with velocities approaching 1 m/s in the Eastern component of the current).

The surface temperature range of the water in the study area varied from 17-22º C.

The following figures show the estimated icthyoplankton abundance and distribution together with the lines that indicate the most representative dynamic topography found in the zone (considering the level of 200 db as reference). The displacement that the icthyoplanktonic population experiences due to the dominant surface currents is clearly shown in the figures.

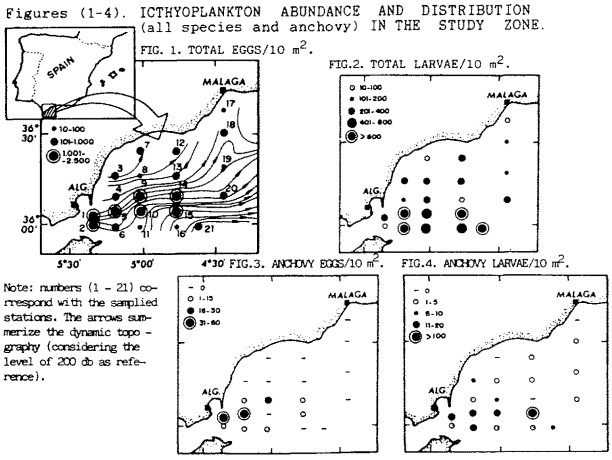
In the case of fish eggs (total species and anchovy, Fig.1 & 3), the maximum densities appear just in the sampling stations closer to the Strait.

The delayed development state found in these fish eggs shows that such sampling stations do not represent spawning sites and therefore, the icthyoplankton material collected from them is imported. Taking into account the direction and high velocity of the current, it can be assumed that they come from the atlantic part of the Strait.

In the particular case of anchovy fish eggs it has been proved that the majority of these are in advanced states (viii, ix & x) and, taking into account the temperature of the water, they are over 24 hours old (in such waters, the embryonic development of this species should take less than 48 hours).

With regard to anchovy larvae, a total of 135 specimens of sizes between 2 and 13 mm have been found (the sizes were taken from specimens kept in formaldehyde). 87 % of these specimens measure $\leqslant$ 5 mm in length (their approximate ages, after the eclosion, vary from 0 to about 5 days). The spatial distribution has been extensive (there were only 3 negative sampling stations). The largest concentrations were found in waters under direct influence from the jet. Particularly, station 15 gives the maximum (estimated) larval density of this species (107 larvae/10 m2). The only gilt sardine larvae (*Sardinella aurita*) found in the study zone appeared in the before mentioned sampling station. As this species is characteristic to more warm waters, its presence could only be due to the transport caused by the gyre from waters situated more to the South.

Figures (1-4). ICTHYOPLANKTON ABUNDANCE AND DISTRIBUTION (all species and anchovy) IN THE STUDY ZONE.



Etude préliminaire sur un Gobiidae signalé pour la première fois sur la Côte de Syrie (Méditerranée Orientale)

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Les renseignements concernant la présence de l'espèce *Oxyurichthys papuensis* en Méditerranée sont rares. En effet, BEN TUVIA (1966, 1983 : in WHITEHEAD *et al.*, 1986) signale l'existence de cette espèce mais de façon très rare sur la côte israélienne et comme une espèce migrante de la mer Rouge.

Pour confirmer cette hypothèse, nous avons pêché, au cours de nos sorties en mer, plusieurs individus d'*Oxyurichthys papuensis* qui a été signalé pour la première fois sur la côte de Syrie le 18 septembre 1991. Pêché par chalut, sur une profondeur de 50 mètres en face de la ville de Jableh à 25 Km au sud de Lattaquie (Fig.1); l'ouverture de maille de filet est de 18 à 22 mm. Le fond de la zone de pêche est de nature sablo-vaseuse. Nous avons examiné, en laboratoire, les spécimens à l'aide des clés d'indentification (P.J.P. WHITEHEAD *et al.*, 1986; W. FISCHER *et al.*, 1987). Après comparaisons des caractères morphométriques et méristiques que nous avons noté par l'examen du poisson (Tableau 1) avec celle des références des pays voisins, il est apparu que ces individus appartiennent à l'espèce *Oxyurichthys papuensis* (Fig. 2) qui a migré de la mer Rouge par le Canal de Suez.

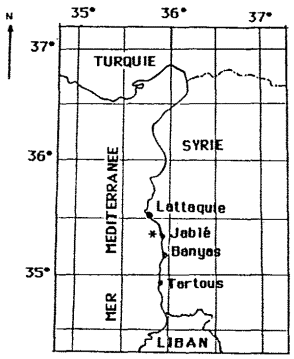

Fig. 1.- Plan de la Côte syrienne et région où les poissons appartenant à *Oxyurichthys papuensis* ont été pêchés.*Stations de prélèvement

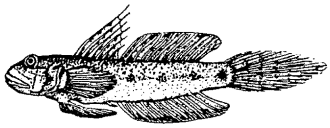

Fig. 2.- Dessin détaillé d'un poisson *Oxyurichthys papuensis*

Il faut signaler également que les plus récentes références de la F.A.O. sur la Méditerranée ne montrent aucun détail sur cette espèce et sa distribution en Méditerranée, mais elles indiquent son nom comme espèce appartenant à la famille des Gobiidae. De plus, MOUNEIMNE (1978) ne signale pas l'existence de cette espèce sur la côte du Liban.

Dans notre travail, nous avons remarqué que cette espèce se pêche toujours à des profondeurs de 45-70 mètres pendant les mois de septembre, octobre, novembre, et le nombre d'individus pêchés par chaque filet est égal à 15-20 ou à 30-40 individus par jour (3 sorties de filet).

Tableau 1. Quelques caractères morphométriques et méristiques d'*Oxyurichthys papuensis*

Longueur totale	150 mm
Longueur standard	115 mm
Hauteur maximum	19 mm
Longueur de la tête	27 mm
Longueur horizontale de l'oeil	5 mm
Distance pré-occulaire	8 mm
Distance pot-occulaire	13 mm
Longueur pré-dorsale	20 mm
Longueur de la nageoire pectorale	28 mm
Nombre de rayons de la 1ère nageoire dorsale	0 - 6
Nombre de rayons de la 2ème nageoire dorsale	0 - 13
Nombre de rayons de la nageoire ventrale	0 - 10
Nombre de rayons de la nageoire anale	0 - 13
Nombre d'écailles en ligne latérale	78 ± 2

Autres caractères : dents de la mâchoire supérieure nettement visibles quand la bouche est fermée

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V

Feeding of *Physics blennoides* (Brünnich, 1768) in the Northern Thyrrhenian Sea : a preliminary note

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A total of 1218 specimens of *Phycis blennoides* were analysed ; they were collected from October 1990 to February 1992, both by trawl surveys and by samplings of commercial landing. The organisms came from the Northern Tyrrhenian Sea, between Elba and Giannutri isles : 40.1% of individuals presented everted stomach, the remaining part showed a fullness index of 0.67. A sample of 366 stomachs containing food, belonging to specimens ranging from 6 to 49 cm of total length (TL), were analyzed. Each stomach was cut out and fixed in 5% seawater formalin. Stomach contents were identified to the lowest taxonomic level possible, counted and weighted. Relative contribution of prey items to the diet was described by percentage of frequency of occurrence (F), percentage by number (N) and percentage by weight (W). A modification of IRI (index of relative importance, PINKAS *et al.*, 1971) was calculated for each prey item as follows : IRI = F(N+W).

Tab. 1

Prey item	F	N	W	IRI	Prey item	F	N	W	IRI
POLYCHAETA n.d.	2.7	1.0	0.2	3.2	*Pasiphaea sivado*	1.4	0.4	0.4	1.1
PELECYPODA n.d	0.3	0.1	*	*	*Processa nouveli*	1.4	0.4	0.7	1.5
CEPHALOPODA					*Processa* sp.	2.7	0.8	0.8	4.3
Sepietta oweniana	0.3	0.1	0.4	0.2	*Polycheles typhlops*	0.5	0.2	0.7	0.5
Heteroteuthis dispar	1.4	0.4	1.0	2.0	*Nephrops norvegicus*	0.5	0.2	3.1	1.7
Sepiolidae n.d.	0.3	0.1	0.3	0.1	*Calocaris macandreae*	36.1	15.4	11.0	953.0
Cephalopoda n.d.	1.9	0.6	1.5	4.0	*Munida intermedia*	1.4	0.4	0.7	1.5
Total Cephalopoda	3.6	1.2	3.2	15.8	*Munida* sp.	1.1	0.3	1.1	1.5
STOMATOPODA					*Geryon longipes*	0.3	0.1	0.1	0.1
Rissoides pallidus	5.5	2.0	8.0	55.0	*Goneplax rhomboides*	7.4	3.0	9.5	92.5
MYSIDACEA					*Liocarcinus depurator*	0.3	0.1	0.2	0.1
Lophogaster typicus	13.4	11.3	1.3	168.8	*Monodaeus couchi*	1.9	0.6	1.1	3.2
Mysidacea n.d.	3.3	2.0	0.2	7.3	*Ebalia* sp.	0.3	0.1	*	*
Total Mysidacea	16.1	13.3	1.5	238.3	Brachyura n.d.	0.8	0.2	0.3	0.4
TANAIDACEA n.d	1.1	0.4	*	0.4	Total Decapoda	76.5	50.1	67.7	9011.7
ISOPODA n.d.	25.7	15.5	4.6	516.6	Crustacea n.d.	16.1	6.8	2.3	146.5
AMPHIPODA n.d	12.3	5.7	0.3	73.8	TUNICATA				
DECAPODA					Thaliacea n.d.	0.3	0.1	*	*
Penaeidae n.d	0.3	0.1	0.5	0.2	PISCES				
Sergestidae n.d	2.2	0.9	0.1	2.2	*Antonogadus megalokynodon*	2.2	0.6	2.0	5.7
Solenocera membranacea	0.8	0.2	0.6	0.6	*Phycis blennoides*	1.1	0.4	1.9	2.5
Alpheus glaber	46.2	23.0	33.1	2591.8	Gadiformes n.d.	0.8	0.3	1.6	1.5
Chlorotocus crassicornis	1.6	0.6	1.7	3.7	*Lesueurigobius* sp.	2.5	0.7	1.5	5.5
Plesionika acanthonotus	0.3	0.1	*	*	*Cepola rubescens*	0.3	0.1	0.1	0.1
Plesionika sp.	3.8	1.2	0.6	6.8	*Cyclothone braueri*	0.3	0.1	*	*
Pandalidae n.d.	0.3	0.1	*	*	*Symphurus* sp.	0.3	0.1	0.6	0.2
Philocheras echinulatus	3.6	1.1	0.8	6.8	Osteichthyes n.d	6.3	1.8	4.4	39.1
Crangonidae n.d	2.2	0.6	0.6	2.6	Total Pisces	13.1	4.1	12.1	212.2

* = < 0.1

The trophic spectrum of *P. blennoides* (Tab. 1) consists mainly of decapods; secondary preys are isopods, mysids, amphipods and fishes. Most of preys are species living below, in, or on the surface layer of the sediment (*Alpheus glaber, Calocaris macandreae, Goneplax rhomboides, Lesueurigobius* sp.); *P. blennoides* carries out its predaction activity in contact with the bottom, using the gustatory and tactile functions of the pelvic fins (GALLARDO-CABELLO, 1986). Studies carried out in the Catalan Sea (MACPHERSON, 1978) and in the Ligurian Sea (RELINI ORSI and FANCIULLI, 1981) confirm the benthophagic habits of this species.

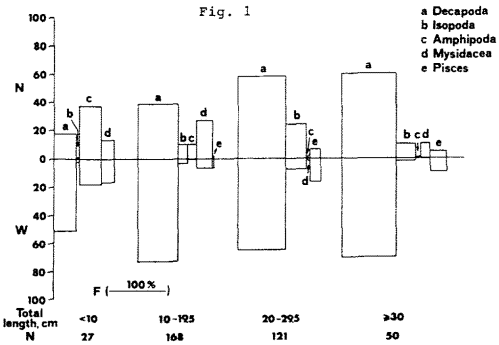

Fig. 1 shows the values of F, N, and W, for size classes, calculated for the most important taxa. Decapods represent the most important food in each size class; amphipods are important in the diet of small specimens and decrease in relative importance in larger individuals; fishes begin to appear in specimens ≥ 10 cm TL, becoming more important in individuals ≥ 20 cm TL; mysids are mainly consumed by small *P. blennoides* whereas isopods are mainly eaten by larger individuals. Further analyses on the trophic spectrum of this species are currently in progress.

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Données préliminaires sur le présence d'une espèce de la famille des *"Pempheridae"* sur la Côte de Syrie (Méditerranée Orientale)

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Jusqu'à présent, aucun renseignement n'est disponible sur l'existence d'un poisson de la famille des Pempheridae dans les eaux syriennes sur la côte Est de la Méditerranée.

En effet, dans les études de MOUNEIMNE (1997) sur les poissons du Liban, il n'y a pas d'indications sur l'existence de cette famille dans les eaux libanaises. D'autre part, dans les fiches d'identification des poissons de la Méditerranée (FISCHER *et al.*, 1987), on signale l'existence d'une seule espèce migrante de la mer Rouge dans le sud de la côte Israélienne.

En outre, dans un inventaire des poissons de Grèce, on indique l'existence d'une seule espèce appartenant à cette famille dans la mer Egée (PAPACONSTANTINOU, 1986).

Dans le cadre de notre travail d'établissement d'un inventaire des poissons dans les eaux de Syrie, nous avons rencontré, le 24 octobre 1991, 2 individus parmi les poissons pêchés dans une région située à 3 Km au nord de Lattaquie (vers la Turquie, fig. 1) et à 13 mètres de profondeur. Nous avons interrogé les pêcheurs locaux pour savoir s'ils avaient rencontré ces poissons auparavant, la réponse a été négative.

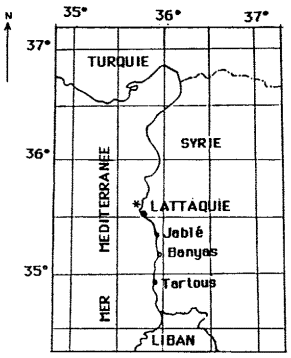

Fig. 1.- Plan de la Côte syrienne et région où les poissons appartenant à *Pempheris vaniculensis* ont été pêchés. * Station de prélèvement.

Après examen de ces deux spécimens à l'aide des clés de classification des poissons (FISCHER *et al.*, 1987; WITHEHEAD *et al.*, 1986; Anomyne, 1976), nous avons déduit que ces spécimens appartiennent à l'espèce *Pempheris vanicolensis* (Cuvier, 1831) de la famille des Pempheridae (fig. 2, tableau 1).

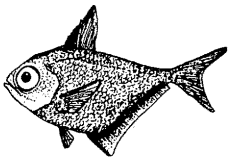

Fig. 2.- *Pempheris vaniculensis* (Cuvier, 1831)

Tableau 1. Caractères morphométriques et méristiques de *Pempheris vaniculensis* (CUVIER 1831).

Longueur totale	88 mm
Longueur standard	70 mm
Hauteur maximum	30 mm
Longueur de la tête	20 mm
Longueur horizontale de l'oeil	9 mm
Distance pré-oculaire	4 mm
Distance pot-oculaire	9 mm
Longueur pré-dorsale	13 mm
Longueur de la nageoire pectorale	19 mm
Nombre de rayons de la nageoire dorsale	VI - 7
Nombre de rayons de la nageoire ventrale	I - 5
Nombre de rayons de la nageoire anale	III - (34-36)
Nombre d'écailles en ligne latérale	59 ± 2

Autres caractères : corps très comprimé; petites dents sur les deux mâchoires; oeil grand.

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Fat reserve/sexual cycle relationship in the Anchovy, *Engraulis encrasicolus* (L.) (Adriatic)

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Introduction

The data on variations in anchovy fat reserves on the one hand and weight of gonads and the most advance gonad stages, - V, VI and VII - on the other, during successive months of the 1975-1984 period are presented.

Material and methods

A total of 12752 anchovy specimens ranging from 14.0 to 17.5 cm were used since the fish length affects the level of mesenteric fat in anchovy (SINOVCIC, 1978). Mesenteric fat was estimated by the scale used by SINOVCIC (*ibid.*) for estimation of mesenteric fat in anchovy. The scale consists of five grades, from 0 to 4, 0 denoting very slim fish and 4 markedly fat fish.

Results

The mean percentage of mesenteric fat grades in the visceral cavity point to the greatest fat quantities in January, when grade 4 presence amounted to 74 % (Fig. 1). This value is the result of an increase of mesenteric fat started in September and proceeding for the successive months. The significant presence of grade 3 was obvious then, and particularly that of the grade 4, which from 57 % in November increased to 71 % in December. During spring a decrease trend is evident which becomes pronounced in summer : in July, and particularly in August, when lowest mesenteric fat quantities were recorded. In August, the 0 grade prevailed (73 %), followed by grade 1 (23 %), whereas the grade 2 was very poorly represented (4 %). Grades 3 and 4, denoting fattest fish were not recorded from a single specimen (Fig. 1). Thereafter a gradual increase in mesenteric fat was recorded in anchovy, indicated by the records of grades 3 and 4. Due to such variations in mesenteric fat during the year, i.e. its greatest levels at the end of winter after unfavourable feeding conditions, and lowest levels in summer when feeding conditions are considerably better, it was assumed that quantity of mesenteric fat was affected by anchovy sexual cycle.

Fig. 2. depicts the oscillations in gonad weight and most advanced stages of gonad maturity (V, VI and VII) compared to the oscillations of greatest mesenteric fat levels expressed as grade 4. Gonad weight and most advanced gonad maturity stages reflect the changes in anchovy sexual cycle. Graphic representation points to an inverse relationship between mesenteric fat quantity and sexual cycle : Grade 4 prevailed in winter, during the resting period of anchovy sexual cycle whereas in summer, and particularly in August, no specimen with this mesenteric fat grade was recorded and *vice versa*.

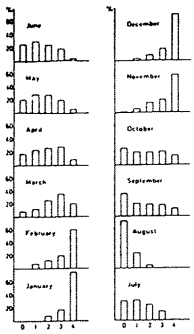

Fig. 1.- Monthly variations of anchovy mesentric fat stages, 1975-1984.

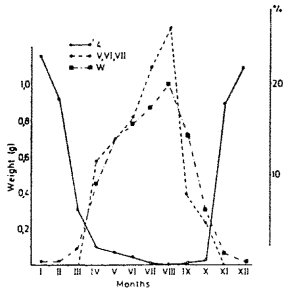

Fig. 2.- Monthly variations of anchovy gonad weight, most developped gonads (V, VI, VII) and stage 4 of mesentric fat, 1975-1984.

Conclusion

Obtained results showed that mesenteric fat quantity varies during the year, as affected by the anchovy sexual cycle. Their variations are inversely related. The greatest quantities of fat reserves were recorded during resting period of anchovy sexual cycle in winter, and lowest quantities during anchovy maximum sexual activity in summer.

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V

Biomass estimates of red bandfish, *Cepola macrophthalma* (L.), in the Western Aegean Sea

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The red bandfish, *Cepola macrophthalma* (Linnaeus, 1758) (= *Cepola rubescens* Linnaeus, 1766), is a benthic species found at depths ranging mainly from 10-20 m to 200 m; it is common in the Mediterranean Sea but not in the Black Sea (TORTONESE, 1986). In Greek waters, it is of no commercial value (as opposed to other Mediterranean countries, e.g. Spain, Italy); it forms a small but significant component of the trawl catch that is discarded (STERGIOU *et al.*, 1992). Here, I present recently derived estimates of its biomass in the Western Aegean Sea (Euboikos and Pagassitikos Gulfs: Fig. 1).

A stratified random sampling design was used to assign 34 trawling stations within three depth strata (0-50 m, 50-100 m and >100 m). Two areas were considered, North and South of the Euripos strait (stations 1 to 24: Region I; stations 25 to 34: Region II) (Fig. 1). Samples were collected by a 425 HP professional trawler, equipped with a 14 mm mesh-size net (knot-to-knot) at the cod-end. Sampling took place seasonally in 1986-1988 at depths ranging from 22 to 222 m. The red bandfish was found at all stations except stations 7, 11,14 and 34. The swept-area technique (e.g. SPARRE *et al.*, 1989) was employed to estimate the biomass of red bandfish: $B=(CPUE)(A)(a)^{-1}(x)^{-1}$ where **B** is the biomass, CPUE is the catch per unit of fishing effort, **A** is the total surface of the stratum, **a** is the area swept by the trawl and **x** is the catchability coefficient. A conservative range of biomass estimates was derived using the trawling speed (3.5 miles/hour), the CPUE of red bandfish at the 34 stations (Fig. 2; high CPUE values at station 2 and 9, 28.2 and 19 kg/h are not shown in Fig. 2), the opening of the trawl (13 m) and two values of **x**: 0.5 and 1.

The results are shown in Table 1. The biomass estimates were generally higher in September and June and ranged in Region I from 33.1 t in March 1988 to 233.2 t in September 1986 and in Region II from 6.4 t in March 1988 to 74 t in June 1987 (Table 1). The mean (1986-1988) biomass amounted 77.5 t (for x=0.5; 38.8 t for x=1) in Region I and 31.5 t (for x=0.5; 15.7 t for x=1) in Region II.

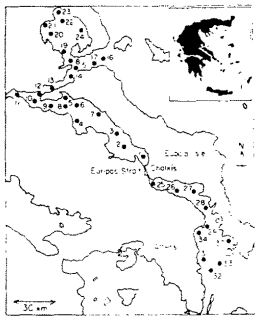

Fig. 1. Map showing location of sampling stations.

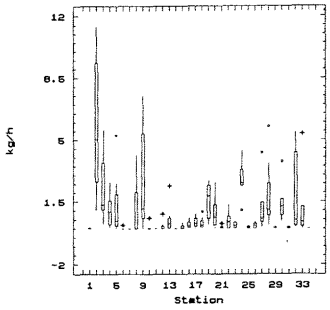

Fig.2 Box-Whiskers plots of the CPUE of red bandfish in the 34 stations (1986-1988) in the study area.

TABLE 1. Seasonal biomass estimates, in t, of red bandfish. A and B=mean (1986-1988) biomass for x=0.5 and 1 respectively. C=area in km^2. D and E=mean (1986-1988) density (kg/km^2) for x=0.5 and 1 respectively.

Region Stratum (m)	Month/Year (x=0.5) 9/86	12/86	3/87	6/87	9/87	12/87	3/88	6/88	A	B	C	D	E
Reg. I	233.2	58.2	33.1	95.0	65.6	41.1	41.2	52.6	77.5	38.8	2230	34.8	17.4
0-50	122.8	27.9	16.3	47.4	45.0	22.5	22.1	32.9	42.2	21.1	741	56.9	28.4
50-100	99.4	29.6	16.5	43.1	17.5	6.0	9.7	16.9	29.8	14.9	1172	25.4	12.7
>100	11.0	0.7	0.3	4.5	3.1	12.6	9.4	2.8	5.5	2.8	317	17.4	8.8
Reg. II	29.8	7.1	56.3	74.0	14.4	36.7	6.4	27.0	31.5	15.7	1404	22.4	11.2
0-50	10.7	3.7	5.6	10.1	6.4	15.1	3.1	18.2	9.1	4.6	546	16.7	8.3
50-100	19.1	3.1	45.2	49.3	7.0	21.6	3.3	8.8	19.7	9.8	680	29.0	14.5
>100	0.0	0.3	5.5	14.6	1.0	0.0	0.0	0.0	2.7	1.3	178	15.2	7.5

The density (kg/km2) was higher in Region I than Region II (Table 1). Because of the selectivity problem, estimates were corrected to account only for specimens with a total length >240 mm (STERGIOU, 1991). The total gross weight of 3351 specimens amounted 57030 g (46115 g in Region I and 10915 g in Region II) and specimens with length >240 mm made up 89.4% (41237 g) and 71.22% (7774 g) of the total gross weight in Regions I and II respectively. Hence, the biomass and density of specimens 240 mm were estimated to be 69.21 t and 31.04 kg/km2 in Region I and 22.43 t and 15.98 kg/km2 in Region II (both for x=0.5).

The geographic differences in the density of red bandfish are consistent with the facts that red bandfish in Region II is characterized by lower t_{max} lower L_{max}, statistically significant smaller length-at-ages for ages >2 yr, higher K, lower L_{oo} and W_{oo}, higher mortality (total, natural) and lower condition than is red bandfish in Region I (STERGIOU *et al.*, 1992). These differences were attributed to the differential conditions of temperature and food prevailing in the two regions (STERGIOU *et al.*, 1992). Although intraspecific differences in life history parameters may involve genetic divergence, they may also be an expression of developmental plasticity in response to proximate environmental parameters; in fact, genetic and phenotypic explanations are not mutually exclusive (e.g. LAM and CALOW, 1989; JENNINGS and BEVERTON, 1991). In any case, such intraspecific life history variations may have important implications for fisheries management (for a discussion see STERGIOU, 1992) which must be taken into account if a common fishery policy is to be reinforced in the Mediterranean Sea.

V

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Abondance de Cétacés : variations saisonnières en Méditerranée et Atlantique en 1991

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Le programme TRANSMEDICET permet de valoriser les transits des navires océanographiques d'IFREMER afin d'étudier la répartition spatio-temporelle des cétacés.

En 1991, nous avons effectué trois missions à trois époques différentes de l'année et nous pouvons faire une estimation des variations saisonnières enregistrées en utilisant un indice d'abondance comparatif.

Méthode

En mer, nous effectuons une vigie continue. Parallèlement, nous relevons les températures de l'eau de surface pour mettre en évidence les zones frontales.

Les indices d'abondance (I.A.= biomasse de cétaces/mille) sont calculés à partir des effectifs d'animaux, du poids moyens de chaque espece (relevés dans la littérature), et des distances parcourues en vigie.

Les conditions météorologiques et l'état de la mer ont une forte influence sur les capacités de détection des animaux. Par conséquent, la force du vent, paramètre qualifiant les conditions d'observations, est indiqué pour chaque I.A. calculé.

Résultats

MISSIONS / ZONES	TRANSMEDICET VII 24-29/04/91 I.A. (t/m)	B	TRANSMEDICET VIII 28/08-6/09/91 I.A. (t/m)	B	TRANSMEDICET X 10-19/12/91 I.A. (t/m)	B
Mer Catalane-Baléares	0,001	Var.	0,019	Var.	0,745	> 4
Cap San Antonio-Cap de Gata	0	> 4	0,011	> 4	0,013	< 4
Mer d'Alboran	0	> 4	0,364	< 4		
Cap St Vincent	0,061	> 4	0,271	> 4		
Portugal	0,012	> 4	0,639	< 4	0,065	< 4
Golfe de Gascogne	0,168	< 4	1,304	< 4	0,541	< 4

Discussion

Pour les trois résultats obtenus en mer Catalane-mer des Baléares, les observations de cétacés ont été réalisées dans des conditions limitant la détection des petits animaux (vents variables ou > 4 d°B). L'indice d'abondance élevé de décembre (0,745 tonne/mille) est dû à la présence de gros cétacés (*Balaenoptera physalus* et *Physeter macrocephalus*).

Pour la région échantillonnée entre le Cap de San Antonio et le Cap de Gata, les I.A. sont faibles ou nuls malgré la présence d'un front thermique de 2,6°c détecté pendant la mission d'avril.

Les conditions météorologiques défavorables à la détection des petits animaux en avril et en août-septembre peuvent expliquer ces résultats. De plus, aucun gros cétacé n'a été observé.

En mer d'Alboran, les deux I.A. (0 et 0,364 tonne/mille) ne sont pas comparables du fait des conditions d'observation trop dissemblables. Par contre, la détection de fronts thermiques en août-septembre (2,6°c en Mer d'Alboran et 5,2°c à Gibraltar) tendrait à expliquer l'I.A. assez élevé trouvé à cette saison.

L'abondance de cétacés au large du Cap St Vincent montre une forte variation saisonnière entre avril (0,061 tonne/mille) et août-septembre (0,271 tonne/mille). De plus, en avril, seuls des globicéphales (*Globicephala melas*) ont été rencontrés alors qu'une plus grande diversité specifique était détectee en août-septembre (*Tursiops truncatus*, *Delphinus delphis* et autres dauphins non identifiés).

Pour le Portugal, nous retrouvons une forte abondance de cétacés en été (0,639 tonne/mille, dont un *Balaenoptera physalus*) alors qu'elle n'est que de 0,065 tonne/mille en décembre (d°B > 4 dans les deux cas).

Dans le golfe de Gascogne, les conditions d'observation favorables rencontrées lors des 3 missions permettent de mettre en évidence une variation saisonnière significative. Par contre, la diversité spécifique est inversement proportionnelle aux I.A. : *Globicephala melas*, *Tursiops truncatus* et *Delphinus delphis* en avril (I.A.=0,168 tonne/mille), *Balaenoptera physalus* en août-septembre (I.A.=1,304 tonne/mille), *Physeter macrocephalus* et *Globicephala melas* en décembre (I.A.=0,541 tonne/mille) .

Conclusion

Globalement, nous notons une plus forte présence de cétacés pour la mission réalisée en août-septembre, sauf pour la mer Catalane et la mer des Baléares. Mis à part des conditions météorologiques plus favorables par rapport à celles du mois d'avril, ce résultat peut être corrélé à une plus forte activité frontale révélée par les courbes de température.

Nous avons également constaté une plus grande diversité spécifique en août-septembre sur l'ensemble de la mission, sauf pour le golfe de Gascogne et la mer Catalane.

Les indices d'abondance sont plus élevés en Atlantique qu'en Méditerranée sur l'ensemble des trois missions mais ces résultats demandent à être vérifiés en bénéficiant de conditions d'observation similaires.

Examination of the influences of daylight on the catchability of trammel nets used for catching Mullet in Izmir Bay

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In this study, trammel nets which has been used are shown in Fig. 1. The rooms of the net has been set towards shore. The quantities of mullet that have been caught during the night, dusk (between evening civil twilight-sunset) and dawn (morning civil twilight-sunrise time) can be seen in Table 1. As result, most of fish has been caught during the night migrations of mullet towards the shore. Therefore it has been considered that the begining of catching period at evening civil twilight-sunset would be more effective.

				Amount of Mullet		
Locality	Date	Dusk	Down	Dusk	Night	Down
Anganlya Burnu	4-9/12/1991	16.51-17.21	6.42-7.11	3	13	-
				-	10	3
				4	17	3
				6	22	2
		16.51-17.21	6.45-7.12	2	14	-
				5	9	-
Şemikler Azmak Onü	12-17/12/1991	16.52-17.21	6.45-7.12	5	12	2
				3	23	-
				-	19	-
		16.53-17.22	6.47-7.10	3	10	1
				1	11	-
				6	38	-
Kuşburnu	20-25/12/1991	16.54-17.24	6.53-7.22	3	10	-
				6	14	-
				2	9	-
		16.59-17.28	6.55-7.24	-	12	1
				1	10	-
				2	27	-
Çakalburnu	26-30/1/1992	17.01-17.29	6.56-7.26	8	41	5
				5	30	2
				2	19	-
		17.02-17.30	6.58-7.28	2	24	3
				-	13	-
				4	10	-
Karaçaşur ve Çalıbaşı Arası	5-11/1/1992	17.06-17.34	7.02-7.32	2	15	1
				4	10	3
				7	19	-
		17.10-17.38	7.06-7.36	6	22	-
				6	16	1
				4	11	-
				3	13	1
Tuzla	16-19/1/1991	17.15-17.43	7.12-7.42	5	19	4
				5	26	5
		17.17-17.45	7.14-7.44	6	11	1
Total for 34 catching days				121	579	38

Table 1. The catching efficiency of trammel nets as anchored bottom net for catching mullet.

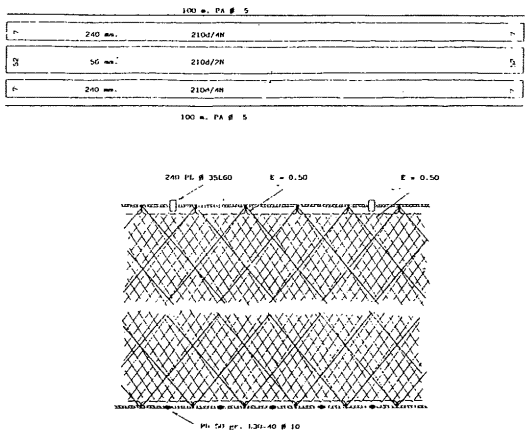

Fig.1 Trammel nets used for catching mullet.

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Introduction to the study of feeding seizing in *Diplodus sargus* (L.) (Pisces Sparidae)

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Introduction.

In perciforms, suction feeding is the most wide spread mechanism for sending on food through the buccal cavity up to the pharyngeal jaws (LAUDER, 1985). Generally the pharyngeal jaws to the handle food before it enters the oesophagus and the buccal jaws do not play any part in the process (LIEM, 1978, LAUDER, 1983, VANDEWALLE *et al.*, 1992). Sparid fishes (perciforms) are supposed to crush preys by the means of the buccal skeletal parts before sending them backward. The aim of the present research is to describe the respective participation of the buccal and pharyngeal jaws in the seizing of decapod crustaceans (crabs) in a sparid fish, *Diplodus sargus*.

Material and methods.

Observations were regisiered by X-ray movies with a 16mm Arriflex camera at a speed of 50 frames sec^{-1}. Small lead markings inserted in the buccal and pharyngeal bones and on the prey allowed to follow the movements.

Results and discussion.

The bones of the snout and jaws are heavy. The dentaries and premaxillae bear from fore to aft incisors and molar teeth of variable size (BAUCHOT et HUREAUX, 1986). The adductores mandibulae are well-developped and present original anterior insertions reinforcing the cohesion of the buccal apparatus in comparison to other perciforms (see for ex. LIEM, 1970, 1978; VANDEWALLE, 1972; BENMOUNA *et al.*, 1984). A_3 and w adductores mandibulae are divided into several bundles inserting more particularly on the ventral aspect of the lower jaw between the dentary and the angular. By contrast, the pharyngeal jaws are poorly specialized except that they are attached to the neurocranium. They are fastened to the parasphenoid by a fibrous pad but do not hang by muscles as in serranids (VANDEWALLE *et al.*, 1992) nor articulate on the neurocranium as in cichlids and labrids (LIEM and GREENWOOD, 1981).

Movements analysis show that the prey is sucked as in the other perciforms, but in certain cases it is seized by the buccal jaws and in other cases it is brought to the pharyngeal jaws and then sent back forwards and catched by the buccal jaws. *D. sargus* presents for the less two crushing strategies : either a fast hammering (fig. 1) or a slow crushing (fig. 2) of the crab, both resulting in almost every case in a dislocation into for the less two parts, the roof of the cephalothorax being separated from the rest of the body. The parts of the prey are then sent on together to the pharyngeal jaws which seize them separately and transport them to the oesophagus just like in serranids (VANDEWALLE *et al*, 1992). Roles in food catching thus seem to be distributed among buccal and pharyngeal jaw in *D. sargus*. A more extended study including the whole alimentary spectrum is presently carried out to determine the stereotypy of the just described behaviour.

Acknowledgments

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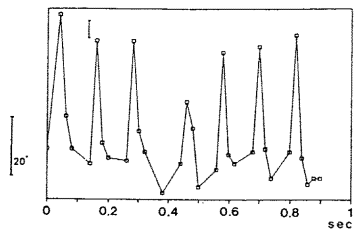

Fig. 1. *Diplodus sargus*. Graph showing the gapes of the mouth during a fast hammering.

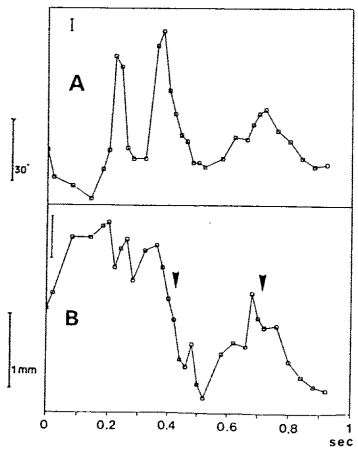

Fig. 2. *Diplodus sargus*. Graphs showing the gapes of the mouth during the preparation and crushing of the prey. A : gapes of the mouth. B : thickness variation of the prey. The arrows indicate the beginning of two crushings.

V

Underwater census of epilithic fish along a depth gradient in the Western Mediterranean Sea

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The analysis of marine hard bottom communities is most successfull when observations and operations are made by means of SCUBA diving. Because traditional equipments of research vessels are uneffective on rocky bottoms, investigations with means of SCUBA even revealed several new fish species in the Mediterranean Sea during the last 25 years.

In 1990 an extensive underwater census was made off Banyuls-sur-Mer/F (near the Spanish border) which regarded the shallow hard substrates until a depth of 25 m. The aim was to get informations on densities of epilithic fish along a depth gradient. Special attention was focussed on the syntopic living small-sized species *Parablennius rouxi* (Cocco) and *Gobius vittatus* Vinc. which equal in their striking colourations: A dark brown band is running from head to tail on a whitish body (Fig. 1). This interrelationship is obviously a case of mimicry but is until now not yet clearly solved (ZANDER & HEYMER 1977, HEYMER & ZANDER 1978).

Fig. 1. Habitus and colouration of *Parablennius rouxi* (left) and *Gobius vittatus* (right). From ZANDER & HEYMER (1977).

Totally, 82 observations and counts were performed which comprised an area of 561 m^2. From 3 to 16 m depth the hard substrates along a fixed transsect at the Ile Grosse off Banyuls-sur-Mer was chosen which equals that of former investigations (ZANDER, 1990). Several counts in the coralligene habitat in 20-25 m depth were added which were compiled from different sites in the near of Banyuls : Cap Bear, Cap Castel and Cap Rederis. The respective rocky substrates were measured out with means of a measuring rope, the inhabiting fish counted and related to the areas.

The densities of 12 epilithic fish species are presented in Fig. 2. *Gobius vittatus* and *Parablennius rouxi* dominate in depths of more than 12 m, but *Gobius xanthocephalus* is very abundant at least in the coralligene. Only young specimens of a size of 3-4 cm are present on the islet which may cause a high total density of 2.3 N m^{-2} whereas the still higher density of 2.6 N m^{-2} in the coralligene is probably due to the extremely structured habitat. Only young *G. vittatus* are also found between the pebbles in 10-12 m (Fig. 2). Lower fish densities are counted in the shallow habitats above 12 m where *G. xanthocephalus* is found until 5 m. *Gobius bucchichii* Steindachner is only present from 0-3 m whereas the larger *G. cobitis* Pallas and *G. geniporus* Val. occur only sporadically on the rocky habitats until 9 or 16 m, respectively (Fig. 2). Among blennioids, *Tripterygion delaisi xanthosoma* ZANDER and HEYMER is present between 5 and 25 m whereas the other *Tripterygion* species have narrower limits. *Parablennius gattorugine* Brünnich is found in this study only sporadically. The fish predator *Scorpaena porcus* L. is in low abundance present in all depths whereas *Lepadogaster* sp. is concentrated in the pebble microhabitat (Fig. 2).

The results reveal that highest total density is found in the coralligene proper but also on the islet and the wall which show also some coralligeneous congregations. These microhabitats are highly structured in contrast to the more unique boulders and pebbles in the shallow areas where clear lower densities are found.

P. rouxi is present in still shallower habitats than observed here but these have to be more structured (HEYMER & ZANDER 1975). Its vertical distribution is wider than that of *G. vittatus* (HEYMER & ZANDER 1978). However, the abundance of *G. vittatus* turns out to be higher than of *P. rouxi* in the present study. Therefore, a third species may be involved in this possible mimicry of cleaning symbiont fishes. In this respect, strong evidence is given by the colouration of young *Coris julis* (L.) which is strikingly similar to those of *P. rouxi* and *G. vittatus*. This suprabenthic fish is distributed over all the depths in great abundances where the possible imitators occur. Further investigations should be focussed on this problem.

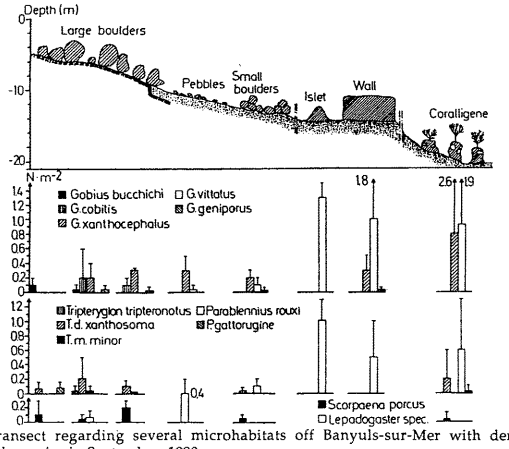

Fig. 2.- Transect regarding several microhabitats off Banyuls-sur-Mer with densities of epilithic fish species in Spetember, 1990.

Acknowledgements

Thanks to Heiko Blessin for help during the diving operations and to Monika Hänel who draw the figures.

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Catch analysis of *Genus pagellus* in the South-Eastern part of the Mediterranean Sea

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Genus *Pagellus* is represented in the Egyptian Mediterranean waters by *Pagellus erythrinus* and *Pagellus acarne*. Inspite of their small contribution to the total catch, they are comprised among the most commercially important species due to their higher dietetic values. *Pagellus* sp. are usually accompanied by a few *Pagrus* species. Trawling fisheries contribute about 50% of the total Mediterranean catch in the last decade. The present word deals with the analysis, distribution and monthly variation of pagellus catch. This study is based on data collected from 149 trawling operations carried out long the Egyptian Mediterranean coast during the period from 1986 to 1988.

Catch analysis revealed that families *Centracanthidae, Mullidae* and *Sparidae* made up respectively the 29.8; 20.2 and 14.9% of the total catches. *Pagellus erythrinus* and *Boops boops* formed 67.9 and 12.9% of the total sparidae catch respectively. The average total fish landings could be distinguished in four periods. The first one is before damming of the Nile River (1962-1964) which is characterised by relatively low catch (1.85% of the total) and explained by the fact that sardine fisheries constituted about the 48% of the total Mediterranean catch before damming. The increase in *Pagellus* catch to 3.9% in the second period (after damming (1965-1967) is related to damming which markedly affected the sardine production (7% of the total Mediterranean catch). During the third period (1968-1977), the average annual catch amounted to 6.4% of the total which can be explained by reduced fishing activity due to the Middle East conflict, followed by a sharp decline of the total Mediterranean yield. In the fourth period (1978-1986) *Pagellus* catch amounted to 3.3%, which could be attributed to the introduction of purse seine that proved itself as an efficient method for obtaining the largest possible quantities of sardine and other pelagic fishes.

Distribution and monthly variation of *Pagellus* catch revealed that *Pagellus* production in front of the Delta was minimum before 1965 (8.7% of the total). Increasing considerably during three successive periods and attaining its maximum value during the last period (42.5% of the total). This increase could be attributed to higher salinity of the sea water in front of the Delta.

There are two peaks in the Pagellus catch, the first one occurred during the periods (1962-1964) and (1978-1986) in April and May (spawning season of *Pagellus erythrinus*) and the second is observed in the fourth period in October (appearance of *Pagellus erythrinus* juveniles in large quantities).

Maximum catch of *Pagellus erythrinus* was obtained in May (98.7% of the total), while that of *Pagellus acarne* (10.8% of the total) occurred in November (spawning season).

Marquage réussi par balise Argos d'un Baleinoptère en pleine mer sans capture

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Le 22 septembre 1991 à 08.17 heure GMT, une balise ARGOS a été accrochée sur un baleinoptère *(Balaenoptera physalus)* de 20m environ, en Méditerranée Nord Occidentale, à 55 miles au sud de Marseille. C'est l'aboutissement du programme ARGOCET, déposé en 1986 (VIALE *et al.*,1986) et mis en chantier en 1988 seulement. De fait, les navires du CNRS nécessaires pour réaliser ce programme ne sont disponibles que deux fois par an ; c'était donc la huitième mission consacrée à ce programme (soit 64 jours dont 20 en présence de baleines). Le Baleinoptère est réputé difficile d'approche car il n'émerge que très peu de temps. Aussi plusieurs équipes étaient en concurrence sur ce thème et plusieurs essais de marquage de grands cétacés ont été tentés avant nous.

B. MATE (1983) a, le premier, fixé une balise ARGOS construite par Telonics (USA) sur le flanc d'une baleine à bosse de 10 mètres capturée accidentellement dans des filets à morue, au large de Terre Neuve. La balise était plaquée à l'aide d'une perche contre le corps du mégaptère et des ancres parapluie se déployant sous l'effet de cartouches l' arrimaient dans le lard et la musculature de la baleine. Cette fixation n'a tenu que 144 heures ; la balise n'a pas survécu. Par la suite B. MATE a poursuivi son programme sur la baleine grise en Californie (MATE, 1984), puis sur le lamentin (MATE *et al.*, 1985). FEDACK *et al.* (1984) ont tenté également de marquer un cachalot aux Açores en utilisant les techniques et le savoir faire des baleiniers de cette région; ce programme par la suite a été poursuivi sur des Beluga dans l'Atlantique Nord avec un type de balise conçu au Japon.

Méthode

La balise est fixée à l'aileron dorsal comme un pendantif dans un lobe d'oreille : elle traine au bout d'un filin de 10 m et l'attache se fait par un petit harpon retenu par des ardillons en alliage inoxydable. Les principes qui ont guidé nos recherches d'une technique sont :

1) utiliser une technique applicable dans la nature sans impliquer de capture de la baleine ni aucun traitement agressif pour elle;

2) utiliser un principe d'accrochage qui soit indélébile et ne mette pas la baleine en danger de septicémie en la gênant le moins possible. Le principe du pendantif a ainsi été adopté; la balise flotte sur le dos de l'animal au bout d'une longueur de filin qui n'a pas été établie au hasard: il faut que la balise soit dans ce qu'on nomme "le schéma corporel" de la baleine : elle ne doit pas la sentir comme un objet étranger ;

3) le principe d'une balise flottant au bout d'un filin a été adopté pour résoudre les premiers impératifs, mais également pour résoudre le problème des trop courtes séquences d'émersion de la baleine. En effet la flottabilité positive de la balise lui permet d'être en surface avec une petite avance sur la baleine et de rester en surface encore un petit laps de temps au moment où l'animal sonde; cela permet donc d'allonger au maximum le temps d'émission de la balise en surface. Un manocontact coupe le circuit d'alimentation électrique de l'émetteur à quelques mètres sous l'eau.

La balise utilisée est le deuxième prototype (ARGOCET II) conçue et construite par J.J PESANDO (Nice). Elle utilise un émetteur construit par CEIS-ESPACE (Toulouse) beaucoup plus petit que celui utilisé dans le 1er prototype ; par suite elle ne pèse que 5 Kg pour une durée d'émission de 2 mois alors que ARGOCET I prévue pour une durée de 6 mois pèse 17 Kg. La source énergétique est fournie par des piles au lithium.

La technique de marquage mise au point par C.P. VIALE consiste à se tenir à 2 ou 3 m, parallèle à la baleine, à la hauteur de l'aileron ; on dispose alors de 3 à 4 secondes pour assurer l'amarrage du harpon.

Le tir a été mis au point sous la responsabilité du Ministère des Armées par modification d'une arme automatique afin de propulser le harpon le plus rapidement possible à travers la nageoire dorsale; cette adaptation a été réalisée par un armurier qui est en même temps un tireur d'élite : P. BRACONNIER de l'Etablissement Régional pour le Matériel en Corse.

Résultats

Le suivi: 41 minutes après avoir été marquée la baleine était localisée par les satellites NOAA et l'information traitée et transmise par le système CLS-ARGOS parvenait sur nos ordinateurs à Nice et à l'Université de Corse. Immédiatement, 7 à 8 messages par jour sont reçus. Au total, 270 messages ont été reçus ; les piles se sont épuisées deux fois plus vite que prévu. La balise ARGOCET a cessé d'émettre le 2 novembre 1991.

Discussion

La précision des localisations obtenues varie de 150 à 350 mètres près. Nous avons été agréablement surpris de cette qualité de la localisation. En effet, l'intérêt de cette précision est de permettre de reporter les positions de la baleine sur des structures thermiques de surface obtenues par télédétection et indiquant les affrontements des masses d'eau. Il s'agit d'interprêter les déplacements de la baleine en fonction des caractéristiques océanographiques des masses d'eau fréquentées De fait le grand nombre de messages reçus a démontré que la baleine est plus souvent en surface qu'on ne l'espérait. Nos observations au cours des campagnes en mer, ont permis d'inventorier des plongées de 3 à 14 minutes les plus fréquentes entre 8 et 12 minutes, séparées par des moments courts d'oxygénation en surface; la baleine souffle 3 fois consécutives en une séquence de 2 à 3 minutes. Mais l'émersion de la nageoire dorsale ne dure que 3 secondes à chaque souffle ; c'est le temps qu'a le tireur pour amarrer la balise. Il semble donc que le baleinoptère méfiant est plus souvent en surface en l'absence de navire océanographique. C'est une marque réconfortante finalement de son adaptation pour survivre aux agressions y compris celles des scientifiques.

Conclusion

Le suivi par télédétection d'un baleinoptère adulte dans son environnement sans aucune capture est devenu une réalité. Il faut maintenant construire une balise capable de durer 6 à 12 mois pour fournir des informations sur les différentes zones utilisées dans le cycle alimentaire annuel.

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A preliminary study of the biology of the spotted flounder, *Citharus linguatula*, in the north Aegean Sea

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The spotted flounder, *Citharus linguatula* L.1758, is one of the most common Pleuronectiformes species in the Greek Seas. It is distributed in waters shallower than 200 m and its commercial importance coincides with specimens larger than 18 cm. The few studies that exist on the spotted flounder deal with its distribution (JARDAS, 1983) and feeding habits (JARDAS, 1984) in the Adriatic Sea, while there are also data on its eggs and larvae in the Algerian waters (MARINARO *et al.*, 1978).

The objective of this work is to present preliminary results on the length and the bathymetrical distribution, the length - weight relationship and the age of the spotted flounder in the north Aegean Sea.

In June 1990, 596 spotted flounders were collected at depths ranging from 70 to 110 m in the north Aegean Sea, by means of a commercial fishing trawler. In each specimen total length was recorded to the nearest mm and weight to the nearest g. Age determination was based on otolith readings.

Lengths were comprised between 6 and 24 cm (Fig. 1). The bulk of the stock was 11 - 14 cm long. Few flounders larger than 18 cm and smaller than 8 cm were collected. The greater number of specimens was fished at waters 100 m deep. A trend of larger individuals to exist in deeper waters was exhibited.

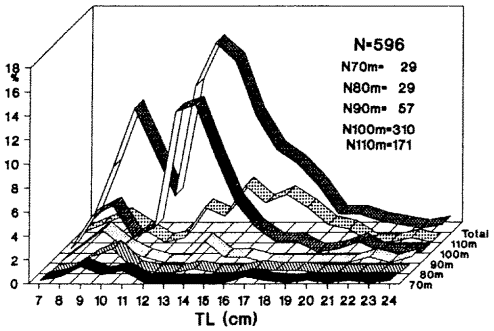

Fig. 1.- Bathymetrical lenght frequency distribution of the spotted flounder in the Aegean Sea in 1990.

Male spotted flounders were the 43.2% of the stock; they were significantly smaller than females (ANOVA : F=17.232, P<0.001), being encountered more frequently in sizes smaller than 13 cm. Females dominated completely beyond 19 cm.

The parameters of the length - weight relationship are shown in Table 1. Growth in weight was isometrical in females and allometrical in males, yielding fish heavier for their size.

Table 1. Parameters (a, b) of the length - weight relationship, 95% confidence interval (c.i.) of the exponent b, correlation coefficient (r^2) and number (N) of the spotted flounders collected in the north Aegean Sea in 1990.

	a	b	c.i.	r^2	N
Males	$3.71*10^{-5}$	3.117	0.0686	0.98	128
Females	$4.60*10^{-5}$	3.075	0.0923	0.96	164
Both	$4.01*10^{-5}$	3.103	0.0586	0.97	292

Five age groups (O-IV) were determined for males and six (O-V) for females. The mean lengths of the male and female spotted flounders at each age did not display significant differences (Table 2).

Table 2. Mean observed total length at each age of the male and female spotted flounder in the north Aegean Sea in June 1990;
c.i.=95% confidence interval, An. Incr.= annual increment, N= number of specimens, t= t-test value.

		Age groups					
		O	I	II	III	IV	V
♂	Mean TL	76.44	108.65	138.61	163.00	187.00	
	c.i.	2.65	6.07	4.49	11.20	-	
	An.Incr.		32.21	29.96	24.39	24.00	
	N	9	17	18	3	1	
♀	Mean TL	80.13	111.14	141.86	168.70	193.75	218.75
	c.i.	4.40	6.42	2.87	4.24	9.15	13.39
	An. Incr.		31.01	30.72	26.84	25.05	25
	N	8	21	22	20	4	4
	t	1.37	0.55	1.19	0.93		

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V

Early diagenesis and nutrient benthic fluxes in an area South of Po River Delta, Northern Adriatic Sea, Italy

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The aim of this study was to determine the early diagenetic processes that control nutrient exchanges at the sediment-water interface along the line of maximum dispersion of fine solid materials supplied by the Po River.

Intact sediment cores were sampled in late summer 1989 and spring 1990 at 4 stations. Their locations, as shown in fig. 1, were chosen by previous studies (BORTOLUZZI *et al.*, 1986; FRIGNANI *et al.*, 1991). Pore waters -after immediate extrusion in inert atmosphere- (pH, Eh, NH3, N03, P04, S04, Fe, Mn, Ca, Mg, and Alk) and sediments (grain size, Tot-C, Inorg-C, Tot-P, P-Fe, P-Ca, Org-P, Fe, Mn) were analysed at 1 cm resolution.

The results outline a clear-cut difference between the diagenetic processes at the station in the proximal prodelta of the main Po River mouth (st. 32) and those of southern stations (sts. 24, 16, and 7).

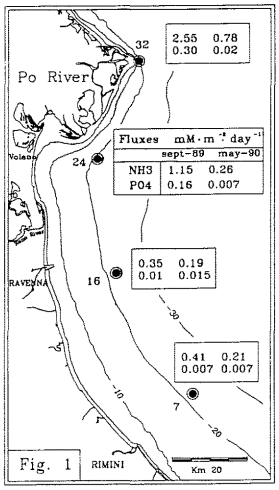

Fig. 1

Station 32 is characterized by anaerobic decomposition of organic matter, in particular by sulphate reduction (ELDERFIELD *et al.*, 1981; VAL KLUMP et *al.*, 1981). In addition Fe and Mn hydroxides reduction processes take place. The pore water profiles (fig. 2) present a large amount of organic matter decomposition products (Tot-C02, NH3, P04), while the precipitation of Fe as sulphide occours in the first 20-30 cm. Below this depth sulphate reduction is no longer present, since all S04 ions have been consumed. Such conditions are due to the fast burial of flocculated river sediments that contain large amounts of very reactive organic matter and inorganic compounds (Fe and Mn hydroxides). In contrast, in stations 24, 16, and 7 aerobic conditions prevail increasing southward. The organic matter is extensively degraded in the first surficial centimetres, as shown by NH3, Tot-C02, and P04 peaks (fig. 2), as well as by S04 values which are approximately constant even down to depth. This is due to:

a) less reactive river-borne organic matter, that was decomposed during lengthy transport in suspension;

b) lower sedimentation rate and frequent resuspensions that cause deposited sediments to experience longer oxic metabolization reactions before their final burial.

The differences found in diagenetic processes are also evidenced by the determinations of nutrient fluxes (P04, NH3) at the sediment-water interface. Fluxes were calculated by FICK's first law from pore water profiles.

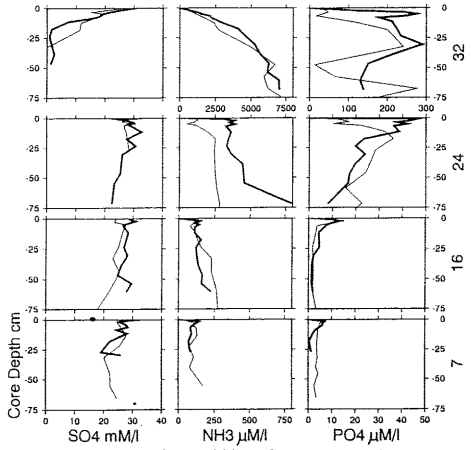

Fig. 2.- Pore waters profiles. Bold lines Sept-89, normal lines May-90.

The results for both seasons show higher flux values in station 32, where subsurficial anoxic conditions result in higher concentration gradients. From stations 24 to 7 fluxes decrease progressively southward. In the late summer period, the high temperature enhances the rate of microbical activity causing the release of large quantities of nutrients into pore waters. This in turn increases flux values at the interface, in particular at stations 24 and 32. At stations 16 and 7 the calculated fluxes are comparable with those calculated in the same area by GIORDANI and HAMMOND, 1985. Station 32, in late summer, shows fluxes similar to those determined in lagoonal environments (Sacca di Goro, BARBANTI *et al.*, 1992).

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Depositional and stratigraphical setting of the recent deposits in Southern Adriatic: Results of AD91 Cruise

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The AD91 Cruise, carried out in the Southern Adriatic Sea, characterized by a complex shelf-slope system and a deep basin (Fig. 1), was held in order to ameliorate the knowledge about the Recent to modern sedimentary pattern of the Apulian margin as well as benthic Foraminifers thanato- and bio-coenoses by University of Bologna and Institute for Marine Geology of the Italian CNR.

Low frequency sub-bottom and high resolution seismic reflection profiles have been recorded. Box cores and gravity cores (distributed in 33 stations) were taken at all 100 m isobaths. At 20 stations the sediment top (5-10 cm) was sliced, and stained with Bengal Rose, for the recognition of living Foraminifers. These samples were preserved in ethyl alcohol.

At 13 stations short sediment cores were sampled with a gravity corer provided with 4 m Or casing. The faunas contained in the top and bottom of each segment (1.20 m in length) or each core were provisionally studied.

The preliminary study of foraminiferal associations and of acoustic data allowed a first step toward the interpretation of the depositional and stratigraphical setting of the most recent deposits. On the whole area, a shelf-wide regional unconformity (U- horizon) overlaid by a thin of modern dei osils is the most prominent recognizable feature (Fig. 2a, b).

On the shelf it marks a sharp erosive surface connected to the last glacioeustatic sea level changes. In the northern sector (Gulf of Manfredonia) the deposits reach a maximum thickness of about 25-30 msec, and they evidence significant variations in the terrigenous input, probably due to climatic changes during the Pleistocene-Holocene transition.

Off the Gargano Promontory, a progradational growth of the margin, with at least three inner clinoform progadational growth, was recognized (Fig. 2b).

In the southern sector (Bari-Brindisi area) the modern shelf deposits are limited to a few meters (Fig. 2c). Active distensional tectonic seem to affect the shelf-slope system, as testified by the morphology and by the Early Pleistocene deposits overlaid by a few centimeters thick Holocence clay cover.

Along the whole margin the sedimentary cover is extensively affected by deformative events of several kinds and amplitude (Fig. 2d), detected also in the basin area, where the sediment accumulation rate estimated to be comprised belween 10 and 40 cm/ky.

Fig. 1.- Bathymetric map of the South Adriatic Sea (data from GIORGETTI and MOSETTI, 1969 and from FABBRI and GALLIGNANI, 1972; modified).
1. isobaths in meters; 2. seismic lines showed in Fig. 2; location of gravity cores (3) and box cores (4).

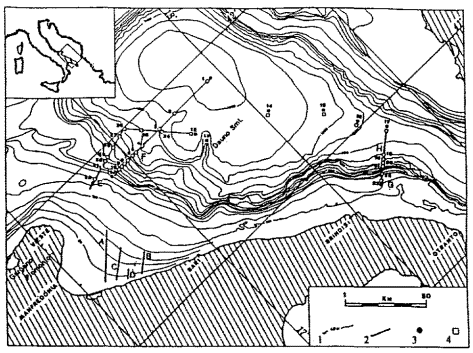
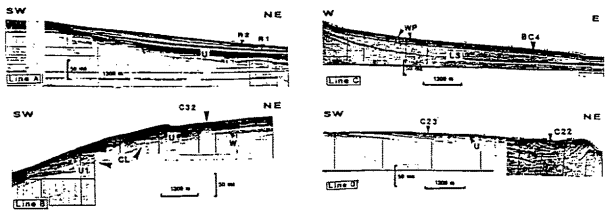


Fig. 2.- 3.5 kHz profiles across the Northern shelf edge (Lines A and B), the basin (Line C) and the Southern outher shelf (Line D) (see Fig. 1 for locations).
U = Last Glacial erosive surface; CL = Late Pleistocene clinoform signmoid sequence; U1 = erosive surface cutting the earlier stage of propagation; W = buried wedge; WP = lens-shaped body acoustically transparent.



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Suspended matter in the Gulf of Venice (Northern Adriatic Sea): years 1990-1991

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The mechanisms of production of suspended matter are widely recognized to be related mainly to the riverine supply and to the biological activity, especially in a basin like the Adriatic.

In the northern part of the Adriatic Sea, the predominant suppliers of suspended matter are the rivers, and, among these, the Po River is undoubtely the main.

In some periods of the year, when the environmental conditions are favourable, the particulate matter supplied by the rivers is accompanied by the products of the biological activity that in some conditions can be very relevant.

The present paper refers about a study on particulate matter carried out from March 1990 to November 1991 in the Gulf of Venice.

An example of the distribution of particulate matter at a basin scale is the result of a survey done in May 1990, that showed the typical features of the suspended matter distribution at the beginning of the stratification period, in which the Po River plume is well developed and north-eastward deflected, with concentration values at the plume front of the order of 10 mg dm^{-3} at the surface, 15 nautical miles off of the river mouth.

The observations on suspended matter were carried out on three stations in the Gulf of Venice, with monthly frequence, and deal with the Total Suspended Matter (TSM) concentration, the content in Particulate Organic Carbon (POC) and Particulate Nitrogen (PN), together with the measurements of standard hydrological properties.

In Tab. I the average values, at different depths, for TSM (expressed as dry weight, DW), organic and inorganic fractioning, POC and PN are reported, taking into consideration the same periods of the two years of observations, to allow a better comparison.

In the summer 1991 appeared in the Northern Adriatic Sea a noticeable amount of gel-like aggregates; on the contrary, in the previous year, these were not observed.

In our data this is evidenced by the increase of the total amount of suspended matter and particularly of the organic carbon. Looking at the data in detail, we can observe that this increase was particularly striking in the layer from surface to 20 m (about 2 times), whereas at the bottom the POC concentration remained substantially unchanged. These differences could also be due to the different meteo-hydrological regimes that took place in 1990 and 1991.

During the 1991 we realized some preliminary measurements of sedimentation fluxes, utilizing two fixed sediment traps located in the Gulf of Venice. We choosed one station in the transition area between the coastal zone and the open waters, 17 m deep (Station 1), and a second one in open waters, 28 m deep (Station 2).

The preliminary results on sedimentation rates for suspended matter (DW), Organic Carbon (OC) and Total Nitrogen (TN) are reported in Tab. II.

These data, in the period from April to September 1991, suggest that the sedimentation conditions are homogeneous in the two stations, with the same variations of sedimentation rates in time. The unique constant difference is related to the content of organic carbon, that always appeared to be higher in the station closer to the coast.

	DEPTH m	DW mg/dm3	INORG mg/dm3	ORG %	POC ug/dm3	PN ug/dm3	C/N	SAMPLES n
June-October 1990								
	0.5	2.34	1.49	43.24	158.9	21.0	9.0	16
	5	2.04	1.30	43.28	160.3	20.7	9.2	16
	10	1.92	1.25	46.46	143.9	20.2	8.6	16
	20	2.28	1.44	46.07	176.4	26.1	8.4	8
	>20	2.10	1.40	40.24	161.0	26.1	7.7	12
June-October 1991								
	0.5	2.73	1.50	49.14	315.1	40.9	9.0	15
	5	2.40	1.10	51.34	316.4	40.4	8.9	14
	10	2.52	1.40	49.35	315.7	40.8	9.0	15
	20	3.26	1.86	46.83	210.0	31.7	7.8	9
	>20	3.65	2.52	33.23	168.0	26.5	7.6	9

TAB. I

STATION	PERIOD	DAYS	DW g/m2/day	OC g/m2/day	OC %	TN g/m2/day	TN %
1	Apr-Jul 91	84	23	0.56	2.39	0.06	0.28
2	Apr-Jul 91	91	25	0.48	1.92	0.06	0.23
1	Jul-Sep 91	59	4	0.17	4.24	0.02	0.55
2	Jul-Sep 91	56	3	0.13	3.68	0.01	0.43

TAB. II

Benthic Foraminifera as recorders of sea level changes in Adriatic Sea

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The study of benthic Foraminifera, carried out in eight cores collected in the middle Adriatic Sea, allowed to follow the sea level changes occurred during the last Deglaciation. For dating the variations occurred in the time space under investigation, the planctonic Foraminifera biostratigraphy of BORSETTI *et al.* 1992 (present issue) has been used.

In the high morphological features (Tremiti Islands) a true shoreline is present at the bottom of two cores (Ad 85-33 and Adr 88-12). In the other cores a sea level change is testified by the variation of the assemblages, when deep indicators are substituted by the shallower ones.

On the basis of planctonic assemblages in three cores from the "Depressione Meso Adriatica" (DMA) IN 68-21, Ad 85-30 and In 68-16, the last de-glacial (to 15,000 yrs B.P.), the Younger Dryas (11,000-10,000 yrs B.P.) and the Holocene have been recognize. Cores IN 68-22, Adr 88-12 and Ad 85-33 contain only Holocenic sediments as testified by the high frequency of *Globigerinoides* ex gr. *ruber* and by the *Globorotalia inflata* peak. In fact these two bioevents are characteristic of Holocene in Adriatic Sea (BORSETTI *et al.* 1992, present issue). Ad 85-33 and Adr 88-12 present a shoreline at the base. Finally Holocene sediments are present only in the upper part of Ad 85-34 and Adr 88-13.

In the DMA core, during the de-glacial period, benthic fauna is characterized by a circalittoral (depth >50 meters) assemblage (*Uvigerina* spp, *Cassidulina laevigata carinata, Hyalinea balthica, Trifarina angulosa, Cibicidoides pachyderma, Bulimina* spp and *Miliolids*); during the Younger Dryas time a shallower environment is testified by the disappearance and/or strong decrease of the deeper species and the occurrence of *Elphidium decipiens*. In the Holocene (COLANTONI *et al.*, 1989) the circalittoral assemblage replaced again the Y. D. one.

In the core IN 68-22 almost interely circalittoral fauna is present. A slight shallower environment is detected by the occurrence of *Elphidium* spp at the base of the core only.

In the lower part of Ad 85-33 and Adr 88-12 cores we can recognize a true coastline (coarse mollusk remains and little pebbles). A deeping of environment from bottom to top of both the cores is demonstrated by the appearance of an infralittoral (depth < 50 meters) association (*Asterigerinata mamilla, Elphidium crispum, Ammonia beccarii, Nonionella turgida, Buccella frigida*) followed by a circalittoral one (*Uvigerina* spp, *Cassidulina laevigata carinata, Cibicidoides pachyderma, Bulimina* spp and *Brizalina* spp).

Finally Adr 88-13 and Ad 85-34 present an alternance of circalittoral and infralittoral environments and only the uppermost circalittoral assemblage in each core corresponds to the Flandrian transgression.

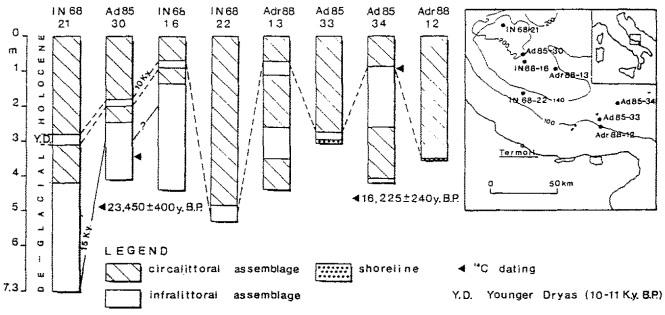
Therefore we can proposed the following evaluations :

1) a sea level rise during the de-glacial interval (15-11,00 yrs B.P.) is testified only in MAD cores, but a shoreline did not form in the sites where cores have been collected

2) the Younger Dryas shallower deposits are recorded in the MAD cores, indicating a sea level fall during this time interval. In the others cores, these sediments are missing (Ad 85-34 and Adr 88-13) or not surely identified (Ad 85-33 and Adr 88-12). Reworking fenomena and sediments transfert occurred during the Flandrian transgression processes, may be responsable of these sedimentary hyatuses (ASIOLI and BORSETTI, 1989)

3) in every cores Holocene sediments are present and benthic Foraminifera content is indicator of the circalittoral environment.

4) The tectonic activity still in the Adriatic sea (COLANTONI *et al.*, 1989) does not allow to extrapolate site by site the shorline records. Many more data are needed in order to identify and to date the Holocene shorline in the Adriatic sea.



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Morphological and hydraulic-sedimentological features of the Lignano tidal inlet (Northern Adriatic Sea)

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In the framework of a scientific program aimed at a systematic hydraulic sedimentological study of all the lagoon tidal inlets in the Northern Adriatic Sea, this paper presents the results of research carried out at the Lignano inlet, the largest of the six mouths of the Marano and Grado lagoons.

The Lignano channel provides the opportunity for an accurate analysis of the natural reaction of a lagoon mouth to the dynamic factors that determine the mobility and deposition of sediments in tidal environments characterized by practically unidirectional two-way current flows. Moreover, no dredging has ever been done because the inlet retains its shape in a natural way.

Morphological-bathymetrical and current measurements were carried out, coupled with a series of samplings within the channel.

The sea bottom configuration shows a clear asymmetry of the inlet with the axis oriented towards the east. This feature is a direct consequence of the stabilisation of the western side of the mouth (construction of the seawall in 1937-1940) as well as of the natural response to the changing equilibrium conditions (erosion of the eastern side), as partially observed by DORIGO (1965).

The local mean tidal range is approx. 65 cm; during spring tides, the excursion can reach 105 cm. Owing to exchanges between the lagoon and the sea through the Lignano mouth, up to 40-50 million m^3 water, both during flood and ebb-tide, can flow through a 4000 m^2 wide liquid section. Tidal currents are therefore considerable, with recorded peaks of 170 cm/s (DORIGO, 1965). The series of launchings of drift crosses that were done both during flood and ebb-tide highlighted that during ebb-tide currents move faster along the eastern part of the channel, while during flood-tide currents flow more towards the centre and more symmetrically about the axis of the channel. The sedimentological results confirm the morphological and current data : the median is perfectly correlated with the bathymetrical pattern of the inlet and with ebb-tide lines. Coarser sediments are located along the strip where maximum speeds was observed, which corresponds to the axis of the channel (greater depths).

This strip has well sorted, symmetric sediment while sorting and skewness tend to worsen near the edges of the channel, which are characterised by a sharp reduction of energy.

There are two main grain-size classes which account for over 90% of the analysed samples : the 150-210 µm class which prevails in the central section of the channel, and the 105-150 µm class which is predominantly at the sides of the channel.

The distribution of frequence percentages of the two main modes has led to a definition of the structure of the sediment masses by varying grain-size, thereby defining the transit axes.

The coarser sediments (150-210 µm) are almost entirely located at greater depth, along the axis of the channel. Here the sediment masses present modal values of 50-60% lined up along the flood lines, as highlighted by current-meter observations, which proves the greater strength of the currents rising along the axis of the channel. On the other hand, the finer sediments (105-150 µm) with modal values greater than 60% line up along the sides of the channel: on the eastern side of the channel, the lining-up corresponds to the ebb-tide linest while on the western sidet finer sand masses seem to be linked to the slower floodtide currents which characterize the lesser depth.

There is therefore a direct correlation between speed/direction of the currents and the distribution of sand masses with different grain-sizes: flood currents are more effective along the axis of the channel, where coarser sands than those located along the sides can be found; the latter are associated with the lower speeds which are characteristic of ebbtide currents on the eastern side and of flood tide currents on the western one.

From the point of view of applications, all types of investigations (bathymetry, current field and sedimentology) have clearly- shown that maximum sediment transport occurs mainly towards the western side of the channel, particularly during ebb- tide. This proves that the axis of the channel tends to shift eastwards and hence that erosion phenomena continue on this side of the channel, thereby highlighting the instability of the eastern side as compared to the western side.

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An experimental approach to multidisciplinary studies on sediment-water interaction processes South of the Po Delta, N. Adriatic Sea, Italy

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In order to develop a descriptive model of the ecosystem of the Northern Adriatic Sea, it is important the uderstanding of biogeochemical cycles of nutrients at the sediment-water interface, within the water columns and in the uppermost sedimentary column. This requires the study of the contribution of bottom and suspended sediment and particulate organic matter to nutrient mass balance. In addition, it is also important the quantification of the exchange potential and its link to early diagenetic processes.

To do this one should study: a) seasonal variations in sediment and water properties, b) response of the sediment and water columns to local and regional hydrodynamics (wave and current regimes), c) source inputs and distributions, d) fluxes quantifications, e) role of the bioturbation processes.

The northern Adriatic Sea, and in particular the region facing the Emilia-Romagna, suffers from coastal water eutrophication, and receives the polluted waters of the Po River, that drains the most industrialized regions of Italy.

To face the problem, an experiment was organized in an area south of the Po Delta, 8.5 Km offshore (Fig. 1), that involved oceanographic, sedimentological, biological, geochemical and radiometric investigations, by mean of extensive field and laboratory work. The work was performed jointly by IGM-CNR, U.S.G.S of Menlo Park and the Department of Animal Biology of University of Modena. The experiment aimed also at the calibration of marine technologies, under the sponsorship of "Progetto Finalizzato Biotecnologie e Strumentazione" (BTBS).

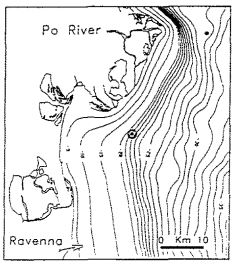


Fig. 1.- Permanent Station location

From late 1989 to mid 1990, the station was occupied by several automatic and semiautomatic collecting and measuring devices. Among them, a) short and long term sediment traps at 2 mt and 10 mt above the bottom, b) radio-buoy with measure of CTD, 02 and turbidity, c) U.S.G.S. tripod GEOPROBE, with 4 stacked EEM current meters, 2 LED optical transmissometers, 4 stacked OBS's, pressure and temperature sensors, d) VACM current meters at 2, 10, 15 mt above the bottom.

In addition to the occupation of the permanent station, two late summer and late winter sampling surveys was performed in order to obtain a more regional characterization.

The field and lab work in the permanent station included a) onboard description, subsampling and measure of chemical and physical parameters on box-corers, b) core sampling for pore waters and solid phase investigations. The laboratory work included: a) grain-size and texture analysis; b) measure of chemical parameter concentrations (nutrients, organic matter, toxics); c) extrusion of cores in inert atmosphere and measure of relevant parameters for diagenetic studies and flux calculations (BARBANTI *et al.*, this volume).

The results from the different approaches and studied items are under integration.

The permanent station's sea bottom is characterized by prevailing black highly hydrated at the surface and gradually compacting clays. Very few discontinuities are present in the sedimentary column, with decomposing shell fragments. The degree of colonization is low, mainly in late summer. At the surface the benthic fauna is dominated by *Corbula Gibba* and *Polichaetes*, where at 20-30 cm it is dominated by a different species of *Polichaetes* (BERGAMINI *et al.*, this volume).

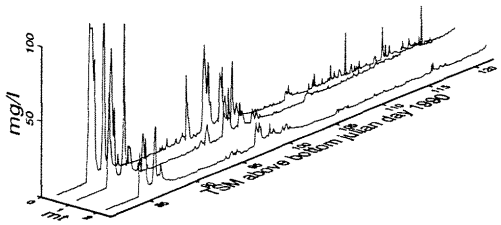
In general, the oxidation is poor. During late summer 1989 there were no evidence of the uppermost oxidized veneer, which is normally present. During summer 1989 there was the maximum of mucus ('marine snow') spreading in the area. This probably provoked abnormally anoxic conditions in the proximity of the bottom.

The GEOPROBE data have been used to determine the response of the sediment under wave stress. During the deployment, two moderate storms transited the area from NE and E, that provoked wave heigths of 2-3 mt, and a remarkable increases of water speed and turbidity at the bottom (Fig. 2) (CACCHIONE *et al.*, this volume). Otherwise, the normal sea-bed conditions were rather quiescent, with weak currents and wave energy, and low amounts of near-bottom suspended sediment. The results from the LED's have been converted to suspended load by re-calibrating the instrumentation with sediments of the site (DRAKE *et al.*, this volume).

The sediment traps collected remarkable quantities of suspended sediments, mainly during the transit of the storms. In general, the correlation between fluxes of sediments in the water column and storm periods is very good. In addition, the sampled materials were used for grain size and chemical analysis.

The water column is uniformely mixed during the winter seasons. In May a very sharp pycnocline is established. The 02 sensor revealed the presence of a very high peak of oxigen in the water column at the end of february. This peak can be probably adscribed to an algal blooming.

Fig. 2.- Total Suspended Matter measured by GEOPROBE's LED's at 3 levels above sea bottom. Storms from NE, E. Maximum wave height 2.5 mt.



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Input, distribution and accumulation of Dolomite in sediments of the Middle Adriatic Sea

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Adriatic sediments are rich in detritic carbonate minerals and in some areas dolomite prevails over calcite. On the basis of information in the literature, the suspended solids carried by rivers to the sea can be quantified as follows :

	solid input (tons/yr)	dolomite (tons/yr)	dolomite (%)
Northern Rivers	$3.0 \cdot 10^6$	$5.9 \cdot 10^5$	19.7
Po River	$15.6 \cdot 10^6$	$6.2 \cdot 10^5$	4.0
Appennine Rivers	$24.0 \cdot 10^6$	$7.2 \cdot 10^5$	3.0

It is clear that the absolute amounts of dolomite delivered to the sea from the three different sources are of the same order of magnitude. However, the concentrations are fairly different and, therefore, dolomite can trace the dispersion of the sediments delivered to the northern Adriatic, while particles from other sources generally cause dilution.

The energy of the environment and the pattern of circulation distribute the main inputs from the northern area throughout the Adriatic Sea. It is always difficult to appreciate the relative contributions of sediments from different sources in every particular area. The aim of this work is to understand how a simple parameter such as dolomite concentration can be used together with other available information as tracer for a quantitative estimate of dispersion and accumulation of fine sediments of northern origin.

Fine sediment accumulation in the Adriatic Sea occurs along a belt parallel to the Italian coast, with rates from 0.04 (Meso Adriatic Depression) to 6.62 $g/cm^2/yr$ (near the mouth of the Isonzo River), depending on the characteristics of the environment (FRIGNANI *et al.*, 1990).

The dolomite content in surficial fine sediments ranges from 8% to over 59% in the northern area (DONAZZOLO *et al.*, 1984). South of the Po delta, the dolomite content progressively decreases from 12% to less than 5% (MAD). Some areas show peak concentrations because of local inputs, confined near to the coast. The focus of this work was on the area between Ancona and Punta Penna (see figure). The southern boundary of the box was chosen because it has virtually no sediment exchange with the surrounding areas.

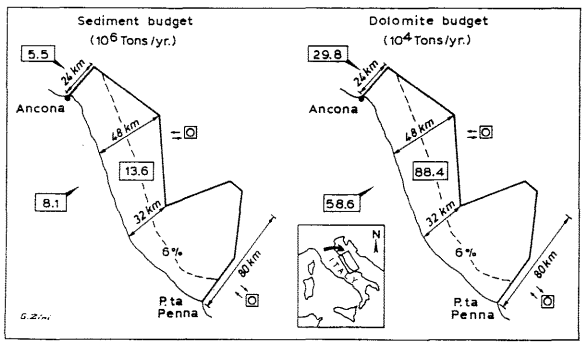
About 120 surficial samples were analysed for calcite and dolomite using the gasvolumetric technique according to JOBSTRAIBIZER (1970). A contour map of ^{210}Pb accumulation rates was drawn in order to calculate the sediment mass balance. For budget calculations, the measured area between each contour line and the midpoint value of accumulation rate is used to estimate the mass of sediment accumulating in each of the areas. The resultant sediment budget equals 13.6×10^6 tons/yr. The sediment discharge by the rivers debouching in the area can be estimated in 8.1×10^6 tons/yr. Assuming negligible or absent exchange at the southern and eastern boundaries, therefore, the input through the upper boundary is 5.5×10^6 tons/yr. This means that rivers deliver as much as 60% of sediment to the study area, while a contribution of about 40% comes from the north, following the cyclonic circulation of the Adriatic Sea.

A map of dolomite distribution was also drawn, based on three different concentration ranges (less than 6%, 6-9%, and 9-12%). Midpoint values of 5%, 7.5%, and 10.5%, respectively, were assigned to each of the areas. The weighed average concentration for the entire study area was found to be 6.5%. Combining this value with the previously calculated amount of sediment deposited on the sea bottom, the total quantity of dolomite accumulating each year is 88.4×10^4 tons/yr.

Since the dolomite delivered by rivers can be estimated in 58.6×10^4 tons/yr. on the basis of the above-mentioned assumptions, it follows that the system input from the northern boundary is 29.8×10^4 tons/yr., i.e. 34% of the total.

Considering the distribution of dolomite concentrations, one notes that the contour line of 6% concentration, which is nearly parallel to the coast, separates two areas with different characteristics. The western area has the highest dolomite concentration (a mean 7.5%) which is very similar to data on river inputs. On the contrary, the mean dolomite concentration of offshore sediments compares with materials coming from north (5 vs. 5.5%, respectively). On the basis of these calculations and of previous studies (CURZI and TOMADIN, 1987), one can say that this line represents fairly well the limit of the influence of the two sources. Sediment from local rivers seems to be confined within the area facing the coast, down to 80m depths approximately. If we divide the sediment budget according to this distribution, the eastern part of it accounts for about 30% of the total sediment accumulation, which is fairly similar to the northern sediment input. This further confirms that materials from the two sources mainly settle in two separate belts, with little exchange between them.

Obviously, these calculations need to be further improved with a comprehensive data set. However, it appears that at least in the Middle Adriatic area, the signature of the dolomite delivered to the sea by the rivers north of the Po is lost.



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Mineralogic and geochemical researches on the cores IN 68-21 and IN 68-5 (Central and Southern Adriatic Sea)

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Eighty samples collected from the cores IN 68-21 and IN 68-5 have been analyzed in order to obtain mineralogic and geochemical characterization of the Adriatic sediments deposited in the Meso-Adriatic Depression and in the South Adriatic deepwater basin respectively during the last 18 KA. This study is included in a research-project concerning both the geochemical records of the paleoenvironmental changes and the determination of the heavy metals levels preceding the human impact on the Adriatic Sea.

The analyses were carried out by XRD, XRF, TG-DTG, SEM-EDS and gasvolumetry.

Calcite (15-30%), dolomite (2-12%), quartz (8-20%), clay minerals (chlorite, muscovite-illite and smectite) and feldspars are the main minerals phases. Their ratios are slightly variable, but calcite/dolomite ratios decrease downward in both cores, beginning from 380-390 cm (~ 12 KA) in IN 68-21 and from 180-190 cm (- 10 KA) in IN 68-5. Volcanogenic layers were found at 135-145 cm and at 258-262 cm (core IN68-5; 9 and 11 KA respectively) and at 99-102 cm and 389-392 cm (core IN 68-21 ; lower layer age: 12 KA).

The sediments bulk chemistry is rather uniform, with SiO_2 (33-43%), Al_2O_3 (9-14%), Fe_2O_3 tot. (3.5-5.7%) and K_2O (1.5-3.3%) lower than average shales, CaO (11-18%) and MgO (2.8-7.8%) higher, in accordance with carbonate contents. Trace elements averages generally agree-well with those of the shales, but Ni and Nb are enriched (1.5 times).

In both cores early diagenetic mobilization of interstitial solutions was active as indicated by Sr and Sr/Ca profiles and by the Mn enrichment (0.61% MnO) in the upper parts of the sapropelitic layer S1 in the core IN 68-5. Diagenetic origin of dolomite and of most calcite is also suggested by their grain size and thermal and chemical behaviors.

The main geochemical features distinguishing the cores are the elemental distributions. In the core IN 68-21 trace elements Ni, Co, Cr, V, Sc, Cu and Zn decrease, and Rb and Ba increase downward in accordance with the behavior of SiO_2, Al_2O_3, TiO_2, MgO and K_2O, while the profiles of the core IN 68-5 are characterized by irregular peaks without any definite trends. The organic matter contents change regularly upward from 0.7 to 1.5% in the core IN 68-21, but increase sharply (from 0.78 to 2.20%) in the core IN 68-5 starting from the sapropelitic layer S1. This reflects differences both in the hydrodynamic regimes and in the sediments supply between the central and southern basins. The Meso-Adriatic Depression seems more sensitive to the postglacial changes in the river loads in comparison with the South Adriatic basin, which is more affected by the circulation and exchanges of the Mediterranean sea waters.

Major and trace elements of volcanic glass are consistent with trachytic, trachyandesitic and phonolitic products, but only the last (135-145 cm of IN 68-5 core) display geochemical features similar to Campanian tephra.

X

Total P and extractable Si in superficial sediments of Northern Adriatic Sea

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On the purpose to verify the presence of a seasonal variability of the amounts of total P and extractable Si, 72 samples of marine sediments collected in 9 sampling stations during 8 cruises carried out in 1990 in Northern Adriatic Sea were analyzed (fig.l).The sediments were sampled with a box corer and a layer of two centimeters was subsampled for the chemical analysis and stored frozen until the analysis.

Triplicate extractions of the two nutrients from sediments were performed after a 2 hours combustion at 550°C and extraction with HCl 1M according to ASPILA (1) ; this method was found to be quantitative for total extractable Si as well ; the analytical determinations were performed by visible spectroscopy (2).

The application of a multivariate statistical analysis (PCA) showed no evidence of dependence of nutrients values on the geographical parameters (Fig. 2).

A next statistical re-examination of the data by Cluster Analysis confirmed a large variability of the concentrations of the nutrients within a same season.This was larger for Si and smaller for P.

P ranged between 160 and 540 mg/Kg d.w. (average value 350 mg/Kg, rsd. 32.2%) ; these values are comparable with those reported by other studies (3,4). Extractable Si ranged between 90 and 790 mg/Kg (average value 198 mg/Kg, rsd. 66.38%) excluding the data of the october cruise ,which were considerably higher ranging between 1510 and 6340 mg/Kg. At the moment this variability can be hardly explained.

The influence of Po river was evident in station 4 (Po mouth) where P and Si levels were higher at 95% level of significance than in the offshore station (St.3), on the relict sand zone, where the depositional contribute is lower.

Total P and extractable Si average concentrations were respectively 501 and 240 mg/Kg for St. 4, while on the relict sands St. 3 the values were 319 and 132 mg/Kg.

An observed correlation between the sediment water content and P concentration can indicate the alloctonous origin of this compound (corr. coeff. 0.589 at 95% level of significance). On the contrary this correlation was not observed for Si.

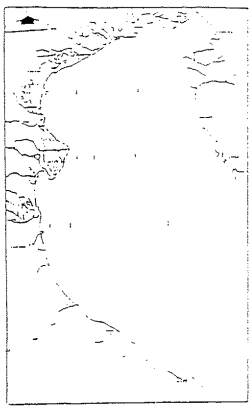

Fig.1 Sampling stations in Northern Adriatic Sea

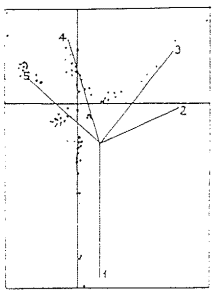

Fig.2 Plot of PCA; 1 depth, 2 longitude, 3 latitude, 4 total P, 5 total Si

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Mercury and Chromium in organisms of the coastal marine area between Po Delta and Ravenna Harbour

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Samples of marine sediments and organisms were collected in March 1990 from the coastal area of the northern Adriatic Sea between Po River Delta and Ravenna Harbour (Fig. 1). In this area, influenced by Po River waters (BARALE *et al.*, 1986), a high deposition of fine materials takes place at a depth higher than 10 m, especially in winter (BORTOLUZZI et *al.*, 1984). Dredging materials from Ravenna Harbour are disposed in a rectangular dumping site (Fig. 1).

Table 1 shows the Hg and Cr contents in the superficial sediments of the studied area (GIANI et *al.*, 1992). Hg and Cr decrease from Delta Po southwards. The maximum Hg concentration is in the harbour-zone due to general pollution of the channel harbour and surrounded salt marshes caused by chemical plants (MISEROCCHI *et al.*, 1990).

The organisms collected were classified, weighed and their length measured. Muscle tissue of specimens of *Gobius niger jozo* (n=10), *Squilla mantis* (n=7) and soft tissue pools (1-8) of specimens of *Ostrea edulis* (n=17), *Crassostrea gigas* (n=45) and *Natica millepunctata* (n=8) caught in the different zones were digested in teflon bombs with nitric acid by a microwave digester. Hg was determined by CVAAS after reduction by SnC12 and Cr analysis was performed by GFAAS (Fig.1 and Fig. 2). The recoveries with respect to MA-A-2(TM) reference material were 100% for total Hg and 88% for total Cr.

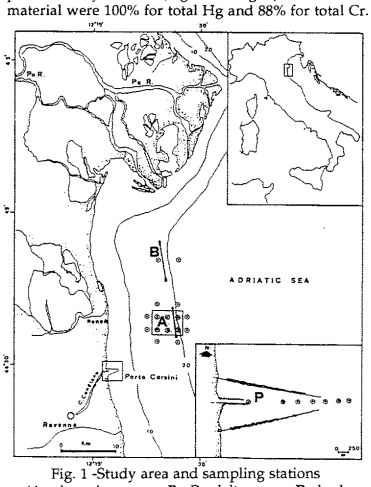

Fig. 1 -Study area and sampling stations
(**A** : dumping-zone ; **B** : Po-delta-zone ; **P** : harbour-zone ;⊙ : sediments ; —> : organisms).

Mercury. Hg values are low. There are no differences between the Hg levels in the same species caught in the different zones. *S. mantis* and *C. gigas* seemed to be the better Hg-concentrating species. In *G. niger jozo* Hg increases with the total length but the values are five-fold lower than those reported by other authors for the same area and about *S. mantis* and *N. millepunctata* our data are lower than the ones too (CIUSA and GIACCIO, 1984). In *O. edulis* and *C. gigas* Hg concentrations are generally lower than the ones found in the Venezia lagoon (PERDICARO, 1989).

Chromium. The Cr letterature data are often not sufficient and not comparable. Fig. 1 shows higher Cr concentration in the bivalves and a gradual decrease from the specimens of the A-zone towards B and P-zone. This observation and the apparent Cr concentration decrease with the total length of the *S. mantis* need further research.

Table 1 - Hg and Cr concentrations (µg/g d.w.) in surface sediments.

Zone	N° of samples	Hg		Cr	
		Range	Av. ± S.D.	Range	Av. ± S.D.
A	14	0.130-0.460	0.278 ± 0.102	123-162	135 ± 14
B	2	0.380-0.508	0.444 ± 0.064	161-171	166 ± 5
C	6	0.120-1.932	0.607 ± 0.653	92-124	113 ± 15

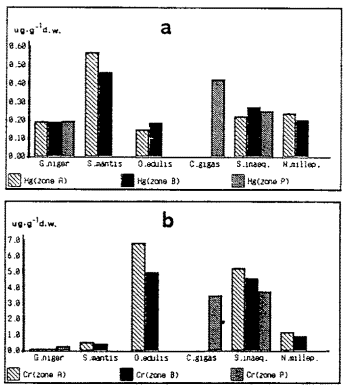

Fig. 2 - Hg average concentration (a) and Cr average concentration (b) in some species caught in the different zones.

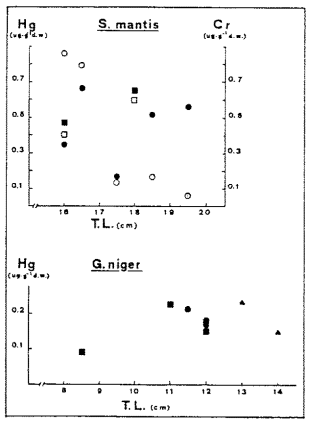

Fig. 3 - Hg and Cr contents versus Total Length (T.L.).
Zone A: Hg (■) and Cr (□).
Zone B: Hg (●) and Cr (⊙).
Zone P: Hg (▲).

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X

Sedimentological aspects of Southern Adriatic Basin Cores

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The Apulian margin consists of a complex shelf-slope system that merges into an elongated deep basin. Four long-axis cores, collected along the basin axis, have been studied from the micropaleontological point of view.

In terms of lithology, bedding and sedimentologic features, at first sight you find what you expect in these cores: that is, more graded beds (turbidites) and continuous deposition in the deepest part of the basin as compared with more elevated parts of the bottom to the South. You would also expect some reworking of sediment and erosion as the bottom shallows and the basin narrows.

However, after biostratigraphic analysis has been done and time lines traced (ecozone boundaries, matched by the $\delta^{18}O$ curve: see BORSETTI *et al.*, this volume), some puzzling elements stand out in the picture. For example, it is quite unclear why core 14, from maximum depth along the transect, where turbidites (both terrigenous and volcaniclastic) can indeed be detected, shows a strong thinning of interval 2. Could that be related to "erratic" erosion by gravity flows? But, where should they have deposited their load? And why the same interval is almost absent in Core 17, where the underlying ones are represented and evidence of turbidity flows is poor to absent?

Judging from these data, we should admit that we know very little about deep water circulation in the Adriatic. Are there bottom currents and 'abyssal storms'? Or is it possible that axial gravity flows interfere with lateral flows? Where are the entry points and dispersal path of these flows? What is the mutual influence of surficial currents and intermediate or deep flows? What their respective role in distributing (or disturbing) sediments?

Some useful information, apart from oceanographic factors, could be gained from detailed morphological and seismic surveys of the basin margins; in particular, they should provide a sufficient coverage parallel to contour lines, in order to detect gullies and other possible pathways for turbidity currents or debris flows.

Fig. 1.- Bathymetric map of the Southern Adriatic Sea (data from GIORGETTI and MOSETTI, 1969 and from FABBRI and GALLIGNANI, 1972; modified).
1, isobath in meters; 2, seismic lines showed in Fig. 2; location of gravity cores (3) and box-cores (4).

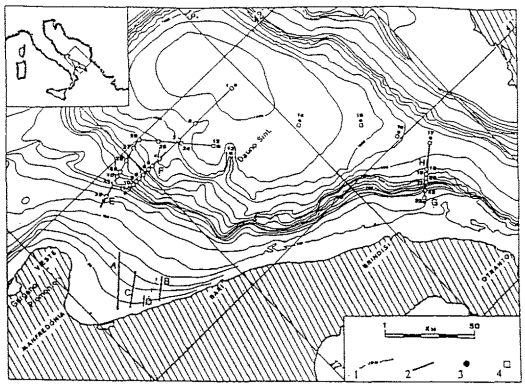
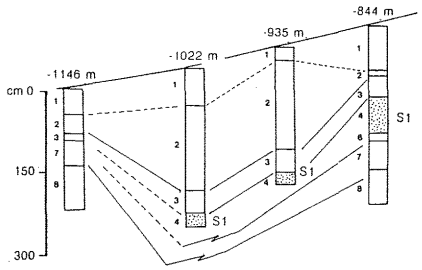


Fig. 2.- Correlation of plantik Foraminifera ecozones (in arabic numbers) and sapropelitic mud layers (dotted intervals) in the four long-axis basin cores.



Late-Quaternary deposits on the Adriatic shelf in a sequence-stratigraphic framework

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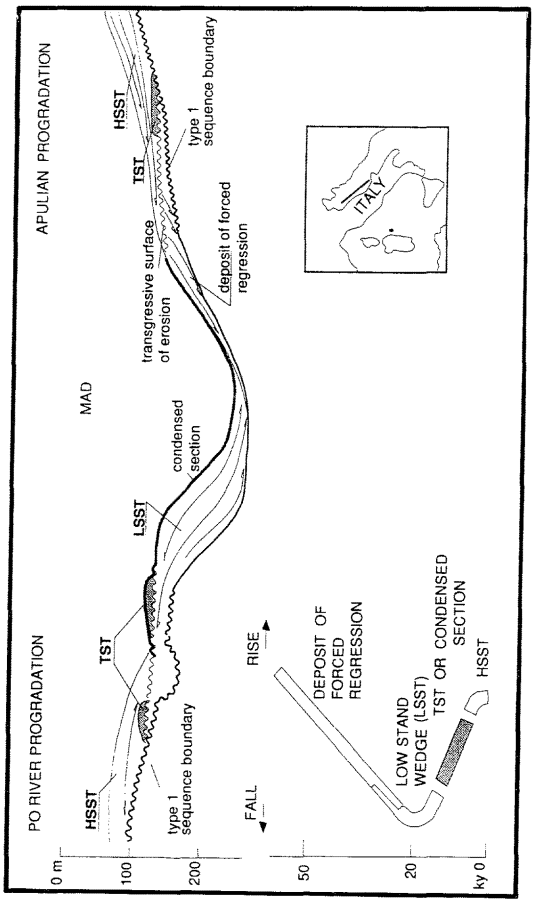
The Adriatic epicontinental sea is an heavily-sedimented basin where deposit geometries and key surfaces within the recentmost Quaternary depositional sequence can satisfactorily be resolved. The growing data-base of samples and high-resolution seismic profiles, gathered in the area, allows a reinterpretation of stratigraphic and sedimentologic data in a sequence-stratigraphic framework. Sequence stratigraphic principles proved to be helpful in interpreting Quaternary deposits on modern continental margins using high-resolution seismic images and shallow sediment samples. This paper documents the variability in shape, size and internal architecture that characterizes late-Quaternary deposits in the Adriatic epicontinental basin; this variability takes place on short distance and reflects the influence of multiple sediment sources.

Several seismic studies provide background information about the style of filling of the heavily-sedimented Plio-Quaternary Adriatic foredeep and foreland basin. Morphologically, two distinct shelf sectors are identified north and south of the Middle Adriatic Depression (MAD); they are characterized by a different style of filling and have likely undergone a different tectonic evolution during the Quaternary. The northern shelf is wide and gentle and encompasses huge quaternary progradational units that show negligible amounts of aggradation. The southern shelf is narrower, steeper less heavily sedimented and complicated by the occurrence of two major structural highs (the NW-SE-oriented Gallignani ridge and the NE-SW-oriented Tremiti high) both active during the Quaternary.

Three basic systems tracts developed during lowstand, rise and highstand of relative sealevel. Systems tracts are composed by several parasequences the stacking pattern of which is typically backstepping in the Transgressive systems tract (TST) and forestepping within the High-stand and Low-stand systems tracts (HSST and LSST). The formation of an extensive surface of subarial exposure is accompanied by fluvial entrenchment in the low-gradient northern Adriatic shelf while the southern area does not show preserved evidence of fluvial channels. In this area, the sequence boundary is a sharp contact at the base of a late-Pleistocene coastal wedge derived from a process of "forced regression" (consisting in the seaward and downward translation of shoreline facies in response to a relative sealevel fall); the contact becomes more gradual and conformable seaward.

The late-Pleistocene wedge of forced regression correlates to a thinner and draped deposit encompassing the southern flank of the MAD, an area of reduced sediment supply; north of this feature the lowstand deposit expands reflecting the influence of the Po lowstand delta. In this area a thick lowstand wedge rests on a type 1 sequence boundary that is extensively cut by fluvial erosion. The southern Adriatic shelf records the deposition of progradational wedges during conditions of relative sea level fall and predates the shelf-margin wedge deposited on the northern flank of the MAD. On the other hand, progradation at the shelf edge from the north encompassed the relative sealevel rise before R inflection point while the southern area was already experiencing transgressive erosion.

Within the recentmost Quaternary depositional sequence in the Adriatic epicontinental basin, the key surfaces that punctuate the stratigraphic record (sequence boundaries, transgressive, ravinement, and flooding surfaces) developed in response to variations of relative sea level modulated by sediment flux and basin physiography. Despite the primary eustatic control, lateral variations in the ratio between sediment flux and rate of change of accomodation are significant even within the short time span encompassed by the late-Quaternary sequence. Lateral variability characterizes thickness and internal organization of all the component systems tracts as well as the timing elapsed during the beveling of erosion surfaces and the formation of condensed sections.



Sedimentologic and geochemical characteristics of the northern and central Adriati sediments

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This work was realized as a part of multidisciplinary studies of the northern and central Adriatic within the ASCOP project. Particular aim of this segment was to determine geochemical characteristics of the surface sediments. Therefore one had to reconstruct the sedimentation pattern of recent sediments. The samples were taken at 33 stations in the period from June 17th to June 30th 1990 by RV Salvatore lo BIANCO (Fig. 1.).
In this paper some sedimentologic and surface chemical characteristics of sediments such as granulometric distribution, mineral composition, carbonate share, organic matter and specific surface area (SSA) are reported. Granulometric composition of analyzed samples gave the sedimentologic pattern as shown in Fig. 1., confirming the data of PIGORINI (1968) and BRAMBATI *et al.* (1983).

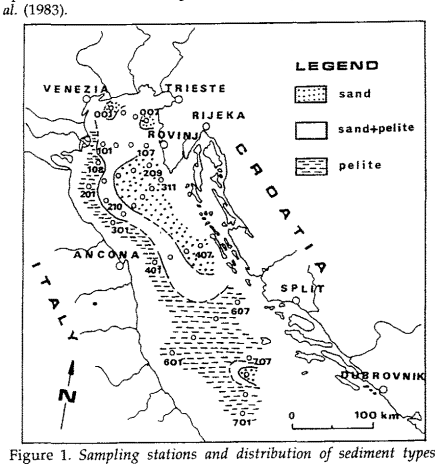

Figure 1. *Sampling stations and distribution of sediment types*

In the eastern part of the investigated area and at the stations 001 and 007 sandy sediments were found at the sea bottom. Toward west increases the pelite shear, so that the western region is characterized by pelitic sediments. Such pattern is typical for the northern Adriatic and 401-407 profile of the central Adriatic. Most of the central region is covered with pelitic sediments with an exception of the station 705, which is 90 % sandy.
Higher share of carbonate fraction is characteristic for sand type sediments, whereas clay minerals (aluminosilicates) are typical for pelitic sediments concentrated mostly in the western and southern part of the investigated region. With respect to surface chemical characteristics, pelites show significantly higher specific surface area compared to sandy sediments (VDOVIC *et al.*, 1991). In Fig. 2. the data specific surface area vs. mean grain size is presented, and data fit the exponential curve with the steep decrease of SSA for grain size classes up to 10 µm followed by continuous decrease approaching 2 m^2/g for classes larger than 50 µm.

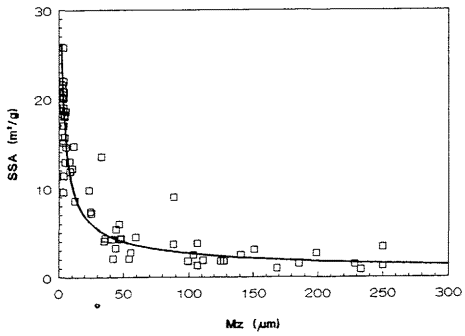

Figure 2. The dependence of the SSA on the mean grain size

The large SSA is not only due to simple geometrical reason (function of equivalent diameter) but more due to solid bulk characteristics, such as morphology and porosity. At the same time pelitic sediments are characterized by significant amount of organic matter which modifies the surface characteristics of the pristine mineral grains (BISCAN *et al.*, 1991). It is evidenced by significant change of SSA after stripping of the organic coating by the H2O2 and heat treatment. Such absorbing ability of pelite sediments is of importance for binding of pollutants. In this sense the presented results could serve for the prediction of role of sediments in transport of pollutants.

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Fresh water discharges in the Adriatic Sea since 17 000 years: influence on organic carbon recycling and deep water ventilation rates

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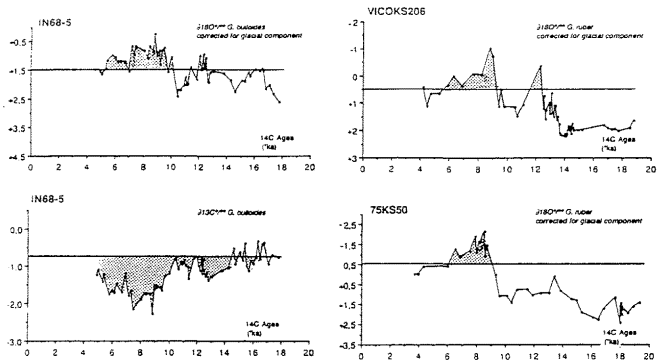
The open ocean deglacial sea level rise was not monotonic. In the Atlantic, in fact, it was marked by two intervals of rapid rise which also corresponded to important meltwater discharges dated at about 12 kyrs and 9.5 kyrs (^{14}C ages) (FAIRBANKS, 1989). Because of its negative water budget (E/P <0) the Mediterranean Sea as a whole, generally behave as an amplifier of the global climatic signals. An exception to the rule is the present day Adriatic Sea, with a positive water budget (E<P).
The oxygen and carbon isotope records of three cores located respecuvely within the central Adriatic Sea: core IN68-5 (41°14'N/18°32'E, 1030m water depth), south west of the Otranto sill: core 88KS206 (39°22'N/18°56'E, 950m water depth) and within the Levantine basin: core 75KS50 (34°41'N/27°00'E, 2290m water depth) have been compared for the period corresponding to the last deglaciation, since about 17 kyrs. The chronological frame is based on oxygen isotope stratigraphy and ^{14}C radiocarbon and AMS datings. The ^{18}O records have been corrected for the ice volume component (FAIRBANKS, 1989). The data show that in the Adriatic as well as immediately south off this basin, two important events of freshwater discharges can be correlated to the meltwater spikes reported for the Atlantic, at about 12 and 9.5 kyrs. The more recent event however lasted longer and ended at about 5 kyrs. A linear relationships between the $\partial^{13}C$ and $\partial^{18}O$ values recorded during these time intervals also supports the hypothesis of a freshwater contamination for both ^{18}O and ^{13}C decreases. By contrast, the first freshwater pulse at 12 kyrs is not recorded in the Levantine core 75KS50 whereas the second one is well marked and coincided in part with the deposition of sapropel S 1.

In addition, since 17 000 years, the surface and deep inorganic carbon (ΣCO_2) was repeatedly depleted in the heavy ^{13}C isotope. The $\Delta\ \partial^{13}C$ difference between *Cicibides pachyderrna* and *Uvigerina peregrina* in core IN68-5 has been used as a proxy record for the estimation of organic carbon fluxes to the sediment since 17 000 yrs, in the central Adriatic Sea. The data suggest that these fluxes were stronger between 16 and 14 kyrs, around 13 kyrs and between 8 and 5 kyrs. The maximal values correspond to the more recent flux. The $\partial^{13}C$ records of *G. bulloides* indicate that shallow water ^{13}C depletion was maximum between 14 and 11 kyrs and again between 9.5 and 5 kyrs. These ^{13}C decreases in the shallow water ΣCO_2 are also recorded in the Levantine basin by *G. ruber*. Whereas these two negative excursions are clearly separated by an episode of ^{13}C enrichment, occurring approximately in coincidence with the Younger Dryas in the Adriatic and Otranto cores, this interruption is less conspicuous in the Levantine basin.
These data highlight the complexity of the factors which controlled the surface water primary production, the downward fluxes of organic carbon to the sediment and the deep ventilation of the eastern Mediterranean basins. Freshwater discharges around 12 and 9.5 kyrs may have seriously hampered deep water formation in the Adriatic Sea (as it occurs today, during "low salinity years"), and consequently lowered the deep ventilation of the eastern mediterranean basin. In the same time, the increase in the Northern Hemisphere insolation which became maximal between 11 and 12 kyrs, caused the seasonal temperature stratification of the surface waters, which may explain that a significant part of the produced organic carbon could have occurred in surface waters. This, in turn, resulted in a ^{13}C depletion of the surficial ΣCO_2. The more recent surficial ^{13}C depletion, near 9.5 kyrs, which duration largely exceeded that of the Atlantic meltwater discharge, reflected the combined effects of important freshwater fluxes and precipitations on the Adriatic and neighbouring basins, with large nutrient inputs from the Po and other italian and yougoslavian rivers associated with- or causing- a low ventilation of the deeper part of the basin. This in turn induced the formation of the most recent sapropel S 1 in the eastern Mediterranean basin.
These data agree well with the recent hypothesis of TROELSTRA *et al.* (1991), that "adverse bottom conditions" in the Eastern Mediterranean may have lasted longer than previouly supposed, from 13.8 kyrs to 6kyrs, according to these authors.



Fresh water influxes in the three studied core during the last deglaciation and ^{13}C depletion in the surface dweiller *G. bulloides*, in Adriatic core IN68-5.

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Adriatic Sea general circulation and its variabilitie (POEM Results)

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The Adriatic Sea basin-wide circulation and its temporal variability is reviewed based on the results of analysis of hydrographic data collected during POEM cruises. Major well known characteristics of the circulation are revealed from the present data set which covers the period from October 1985 to April 1987. A prominent signal associated with the seasonal variability, is identified the outflowing water along the Italian coastline. Differences between autumn and spring in the vein of cold and fresh water along the Italian shelf break, manifest mainly in the temperature field. In the surface layer during the stratified season in the Southern Adriatic the fresh water spreads over the entire surface. On the other sand, during the sprin i.e. the period when the sea is vertically homogeneous, the fresh water remains confined in the surface alongshore boundary layer over the entire lenght of the Italian shoreline. Layers below the seasonal thermocline at the eastern portion of the sea display very weak seasonal signal. A strong signal associated with the inter-annual variations have also been documented from the analysed data set. It mainly appears in the salinity field. It is shown that in the spring 1986 the salinity averaged over the entire water column north of the Palagruza Sill is by 0.3 PSU smaller than in the spring 1987. The same but less prominent difference is noted in the southern Adriatic. These differences are related to the variations in climatic conditions over the area, the river run-off and the Mediterranean water inflow.

Characteristics of the response of the current field in the Kastela Bay to the atmospheric forcing

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Kastela Bay is a small semienclosed basin with total area of 61 km^2 and average depth of 23 m. The bay communicates with the adjacent sea through a relatively wide (1.8 km) and deep mouth (mean depth about 40 m). The principal freshwater source is Jadro River with relatively small discharge (yearly mean about 10 m^3 s^{-1}).

Seven current measurement experiments of approximately two month duration were made in the Kastela Bay from 1980 to 1990. Current measurement stations were placed in the center and in the mouth of the bay where water exchange with the adjacent sea takes place. In each experiment meaurements were made simultaneously at more then one station and several depths. This made possible the determination of vertical and horizontal distribution of current field. Measurements in various seasons allows us to detect intra-seasonal differences in the current field.

Current meter data were analyzed together with appropriate hourly wind and atmospheric pressure data recorded at the meteorological station in the vicinity in order to study the effects of the atmospheric synoptical disturbances on the current field and water exchange with the adjacent sea. Currents and wind stress vectors were decomposed into the east-west and north-south components. All these time series were then low-pass filtered with 24m214 filter (THOMPSON, 1983) to reject tidal and other high frequency motions. Besides of the detailed analyses of low-pass filtered time series, correlation coefficients between north and east components of wind stress and currents were computed for periods with wind speed greater than 5 m/s in order to study the momentum balance (WINANT, 1980). Basic statistical characteristics (mean, standard deviations) were also computed. Correlation coefficients between current components and atmospheric pressure were computed for entire time series. Using linear interpolation for the current profiles, water transports and renewal times were obtained for stations in the mouth of the bay. Schemas of water transports were given for strong wind events.

The most obvious characteristic of all time series is strong variability on a weekly time scale.

Current meter data in the mouth of the bay show well defined two-layer structure for the periods with strong wind events, with surface current in phase with wind, while in deeper layers the phase-lag between wind and currents is 180 (GACIC, 1982; GACIC *et al.*, 1987). Correlation coefficients between currents and wind stress components, as well as average vectors give frictional momentum balance. Great negative correlation coefficients between the current components show polarization of the currents in the mouth in the east-west direction during the strong wind events. Correlation coefficients between east component of currents in the surface layer and atmospheric pressure show incoming flow during the periods with low pressure and outcoming flow during the periods with high pressure. The motions in the lower layers are in the opposite directions. Low pressure is often connected with scirocco (SE) wind, that also drives incoming flow in the surface layer and high pressure is connected with bora (NE) wind that drives outflow in the surface layer (ZORE-ARMANDA, 1980). When the scirocco (bora) wind stops the pressure starts to raise (fall) and opposite circulation in the mouth is established. Deviations from these typical synoptical situations were also observed.

Magnitudes of currents and correlation coefficients between currents and wind stress and currents and atmospheric pressure were smaller for the stations in the center of the basin. The correlation coefficients between wind stress and current components, as well as average current vectors reveal Ekman momentum balance with Ekman transport in the surface layer and compensatory transport in deeper layers.

Calculations of the water transports and renewal times show that the wind is effective mechanism for water exchange in the bay. Water renewal times are of order of two days during the strong wind events.

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Curl of the Bora-Wind and Ekman Pumping in the Southern Adriatic

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Analyzing the vertical distribution of salinity data collected in the southern Adriatic during the October 1985 (POEM 01) cruise, the occurence of a subsurface salinity minimum at the level of the seasonal thermocline was documented. The layer of the subsurface salinity minimum coincided with the maximum of the dissolved oxygen suggesting that ventilation processes have had probably taken place. A possible explanation was that the ventilation was due to the Ekman pumping produced by the curl in the bora-wind field. from the wind measurement data at one location in the adriatic it was evidenced that the bora-wind was blowing for about ten days prior to the sampling interval. The bora-wind field reconstructed on the basis of the climatological data, suggested the occurence of areas of alternating positive or negative Ekman pumping velocities which could generate the subsurface salinity minimum if the area with the downward pumping velocity coincided with the fresh water coastal layer. The nested multilevel model with 25 levels was applied in order to obtain open boundary conditions in Otranto Strait for a 1/24 degree resolution model. The forcing function was asteady bora-wind field having a curl of the order of magnitude as obtained from climatological data. Horizontal and vertical distributions of salinity were presented for selected numerical experiments.

Adriatic Sea primary production (Application of Sea-Wifs to a variable primary production system)

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The Northern Adriatic, due to marked eutrophication gradients over a relatively small area, represents a guitable experimental polygon for testing new methods to estimate and monitor primary production. Even if chlorophyll contents in surface water could be inferred from Sea-WIFS, the ultimate long-term goal of the program is to obtain basin-wide estimate of primary production and to assess its fate.

In the years 1978-1986 the spaceborne Coastal Zone Color Scanner (CZCS) made an important contribution, by mapping phytoplankton concentration in the Adriatic Sea. During the same time period numerous series of experimental cruise-c were carried out in several marine laboratories on the Adriatic coast. The observations, however, were not generally coordinated with the Nimbus transit.

In response to the NASA NRA request for a proposal, a consortium has been formed. It is made up of experts who, in the past, have independently dealt with optical, biological, chemical and physical parameters. They will now carry out a team work for an integrated study of space observations and *in situ* measurements. Details are given below.

The consortium is formed by:

- **Marine Biology Laboratory represents** Osservatorio dell'Alto Adriatico (**OAA**), and that is formed by: Marine Biology Laboratory (**LBM**), The International Centre for Theoretical and Applied Ecology (**CETA**), Institute of Sea Biology - National Research Council (**CNR**), Marine Biological Station Piran, "The Rudjer Boskovic Institute" Center for Marine Research in Rovinj.
- **Consorzio Ricerche Interdipartimentali di Scienze del Mare (CRISM)**
- the **University of Bologna** (Departments of Physics and Computer Science)
- the **Agusta** Systems Company
- the **Telespazio** Company

In particular, four units of the **Osservatorio Alto Adriatico** (**OAA**) formed by; **Marine Biology Laboratory** (**LBM**) Trieste, Italy; Institute of Sea Biology - National Research Council (**CNR**), Venezia, Italy; **Marine Biological Station**, Piran, Slovenia; **"The Rudjer Boskovic Institute" Center for Marine Research**, Rovinj, Croatia; and **Consorzio Ricerche Interdipartimentali di Scienze del Mare** (**CRISM**), Bologna, Italy, will be involved in the "Sea-truth" activities. **The Departments of Physics and Computer Science of the University of Bologna,** Bolognar Italy, will develop the bio-optical algorithms. **Telespazio,** Roma, Italy, will be mainly involved in the image processing activities and in providing all the software tools necessary to support this activity. **Agusta Sistemi,** Tradate (VA), Italy will be mainly involved in taking aerial measurement using a Lidar and, if necessary, other airborne instruments. The research project aims at establishing reliable bio-optical algorithms for chlorophyll, suspended and dissolved organic matter based on Sea-WIFS data at extimating primary production of the Adriatic Sea. The Consortium intends to ask the needed endorsement from the Italian Space Agency and the High Authority of the Adriatic Sea.

The following persons have participated at the project:

S. GHELFO (Technical responsible) (1);
A. BRAMBATI (Project manager) (2);
S. FONDA UMANI (Scientific responsible) (2);
M. CABRINI (Scientific collaborator) (2);
P. FRANCO (Scientific collaborator) (3);
E. FEOLI (Scientific collaborator) (4);
A. BERTOLUZZA (Scientific responsible) (5);
F. CASALI (Scientific responsible) (6);
G. BORZELLI (Scientific responsible) (7);
A. MALEJ (Scientific collaborator) (8);
N. SMODLAKA (Scientific collaborator) (9);
D. DEGOBBIS (Scientific collaborator) (9);
R. PRECALI (Scientific collaborator) (9).

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(4) Center for Theoretical and Applied Ecology, Gorizia (Italy);
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Seiche of eight and six hour periods in the Adriatic Sea

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In order to reproduce bora induced motions on the Adriatic shelf going from the hydrostatic state marked seiche and inertial oscillations are present in modelling results which will be discussed here. Here used model is a levels non-linear model written in semi-staggered grid with forward-backward time scheme.

Considering area of the longitudinal cross-section of the Adriatic basin one can see that "G" point in the Figure 1. to which the area of integration extends, can be identified as the opening of the semi-closed basin surrounded by infinite sea. This semi-enclosed basin is the main part of the the Adriatic shelf. For the Jabuka Pit the results of spectral analysis of the sea level (using Daniell's filter) are given in Figure 2. It is well known that the main periods of Adriatic seiche are 21, 11, 8, 6,... hours (MANCA *et al.*, 1974). In Figure 2 the seiche of 8 and 6 hour periods are pronounced while these of periods of 21 and 11 hour are not. VERCELLI (1941) identified seiche of the period of 21 hours as fundamental of the whole Adriatic, that of the period of 11 hour as binodal seiche of the whole Adriatic and the seiche of of 8 and 6 hour periods in the modelling results as free oscillations of the Adriatic considering it as closed basin. Used boundary conditions and obtained model results confirm that these oscillations are free oscillations of the sea over the Adriatic shelf. Results of spectral analysis of sea-level obtained by the numerical model were tested by spectral analysis of residues (difference between observed and predicted sea-level) at Koper (North Adriatic), Split (Middle Adriatic) and Dubrovnik (South Adriatic). Monthly time-series of residues were analyzed in January 1982 where free oscillations of the whole Adriatic Sea were observed. Seiche of 8 and 6 hour periods were observed at Koper and Split but not at Dubrovnik. This is shown in Figure 3. These experimental results confirmed theoretical results obtained by the model stated that 8 and 6 hour seiches are free oscillations of sea over the Adriatic shelf.

Figure 1 - Cross-section area in function of distance from Otranto to Venezia in 10^6 m^2

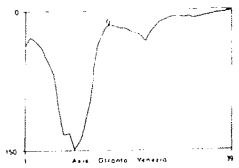


Figure 2 - Spectral density predicted by the model in the Jabuka Pit

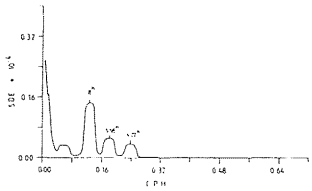
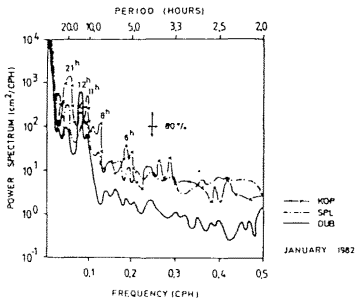


Figure 3 - Observed spectral densities



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Residual Currents in the Northern Adriatic over the Year-long Season

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Sea currents in the northern Adriatic (particularly along the west Istrian coast, Croatia) were frequently measured, at different positions, and in different seasons (KONRAD, PRECALI ed., 1985-1991). Because of specific purposes (ORLIC, 1988; CEROVECKI, 1991) these measurements were usually carried out for one to two months continuously. We were interested in the residual currents variability over the year-long season. Therefore, in May 1989 we started to measure continuously sea currents at one position of the northern Adriatic.

The position of the fixed station (A) was φ=44° 47.27' N, λ=13° 30.00' E (15 NM west of Pula in Istria, 43 m depth).

Measurements were made in the surface (6 m) and bottom layer (37 m) by AANDERAA RCM-4 current meters. The sampling interval was ten minutes.

After decoding of data, twelve hours average values of u and v (i.e. E, N) components were found, and then the five day-moving average was made. In effect this was an equivalent to apply one low-pass filter on the time series data. To express the results of these procedures it is very suitable to plot a progressive vector diagram - hodograph of the residual currents during an one year period. We chose the year 1990, of the surface layer of a considerable station, and the progressive vector diagram hodograph is given in Fig. 1.

We must notice that the thin dot line in Fig. 1. corresponds to the intervals with no measurement data. Because of some technical disturbances during the measurement period (damages of rotor, loosing instruments, etc.) some gaps in the time series exist. We fulfilled the missing data with the curve got by the following method: In every missing data period we interpolated the velocity vectors with the average value of the velocity in the periods of the same duration before and after of the missing data period. (The reason for the use of this method of interpolation was the analysis of intensity of the current vectors during the whole period).

An analysis of the global flow i.e. long-term current variabilities (in the northern Adriatic) could be very important for the analysis and explanation of many annual and long-term processes, for example: for bio- and eutrophication cycles as well as for transport and long-term sedimentation processes.

The long-term variation of the residual currents of the bottom layer and for other periods when the currents were also measured will be presented at the October's ICSEM session.

Acknowledgements

We are grateful to our colleagues Z. STIPIC, R. PRECALI and Ms. A. HRELJA for technical help of the text and diagrams, and to the crew of the RV *"Vila Velebita"*.

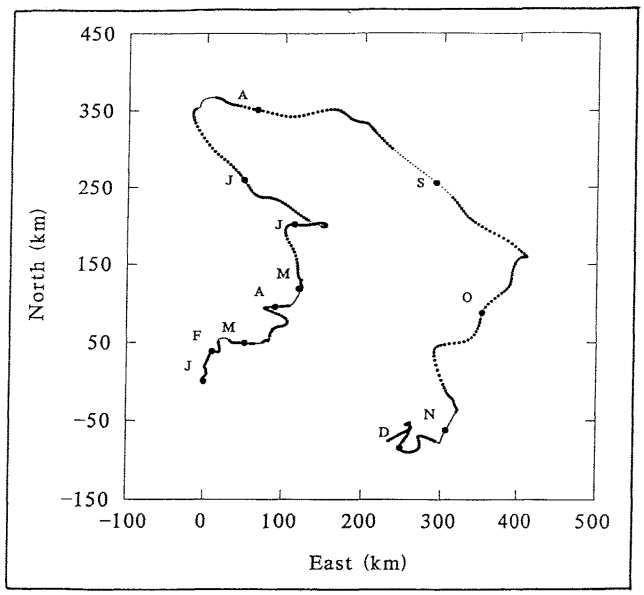

Figure 1. Progressive vector diagram - hodograph of the residual currents in the surface layer at station A.

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Report on the different thermohaline features recorded in the outer part of the Gulf of Trieste (Northern Adriatic) in July 1990 and 1991

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In the frame of the Alpe Adria Project the thermohaline and density structure were recorded in the outer part of the Gulf of Trieste (TR. 3 and TR. 4) in July 1990 and 1991 (Fig. 1). Measurements were carried out using a CTD Idronaut mod. 401 multiparameter probe.

An analysis of the data leads to the identification of two welldistinct thermohaline situations. In the spring and at the beginning of summer 1990 the volume of freshwater injected in the basin by the Tagliamento and Isonzo Rivers was lower than in the previous years, contributing to the absence of a light surface layer with low salinity and high buoyancy and of a thermohaline discontinuity. This condition led to radiative heating of the whole water column, including the deep higher-density nucleus formed in winter. The absence of freshwater inflows caused the drifting of high-salinity water masses from the Middle Adriatic and their spreading over the Gulf up to the surface layers, thanks to the absence of thermohaline stratification and to the presence of comparable density water. This water advected from the south showed the following values: a) in the outer part of the Gulf: temperature 21.70 ± .03°C, salinity 37.54 ± .01 PSU and γt 26.27 ± .01 kg m ; b) in the inner part: temperature 22.51 ± .05°C, salinity 37.44 ± .01 PSU and γt 25.95 ± .02 kg m . (1)

In 1991 fluvial inputs created a situation that was the opposite of the 1990'one. The presence of a surface layer with low salinity and high buoyancy, separated from the dense waters of the bottom layer by a well-defined pycnocline which was extended over most of the water column (3-12 m). This situation limited radiative heating to the surface mass, maintaining a deep low-temperature nucleus. These thermohaline conditions greatly reduced the influence of advection waters coming from the Middle Adriatic. In July 1991, in fact, such inflows scarcely affected the Gulf of Trieste (Fig. 2).

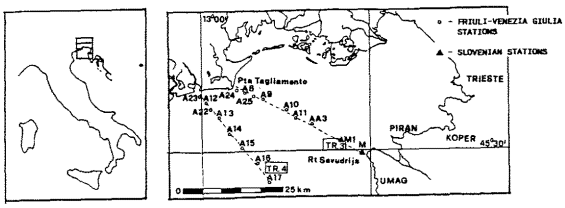

Fig. 1.- Distribution of the sampling sites

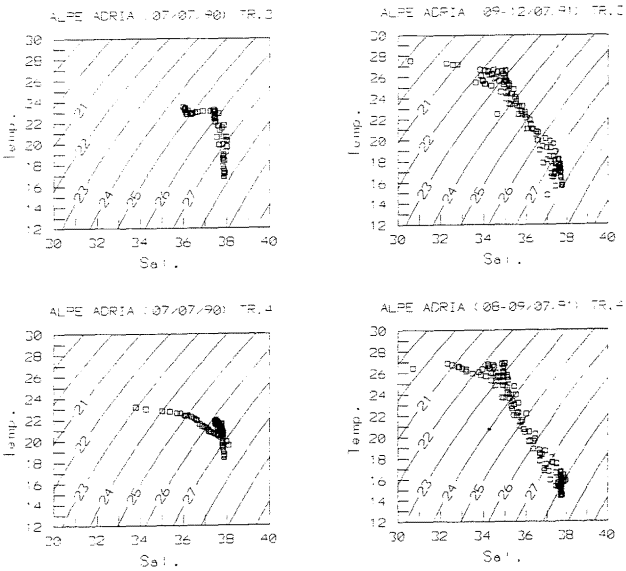

Fig. 2.- Temperature and salinity distribution in july 1990-1991 measurement carried out using a CTD multiparamenter probe.

(1) The confidence limits of the means are obtained from the standart error

This work has been supported by the Alpe Adria 1990/1991 Project (Friuli-Venezia Giulia and Veneto Regions - Italy - and Republics of Slovenia and Croatia)

Transmission of the seiche energy through the Otranto Strait

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Thirteen episodes of seiches, recorded at three locations along the east Adriatic coast between 1963 and 1986, were analysed. Energy spectra of residual sea levels showed that the first Adriatic mode, whose period is 21.6 hours, dominated over the others. Therefore, a band-pass filter was applied to isolate this oscillation. Intervals with free oscillations only were determined by analysing envelopes of filtered residuals. Envelopes covering the separated intervals were represented by exponential curves wherefrom decay times were estimated. The average decay time obtained in that way for three analysed stations (Bakar, Split and Dubrovnik) equalled 3.3 ± 1.2 days. This compared favourably well with results published by GODIN and TROTTI (1975) for the Trieste station.

Two flat-bottom models were used to interpret the empirical results. The first model, incorporating linear bottom friction (DEFANT, 1961), reproduced the average decay time with the bottom-friction coefficient $k = 1.74 \times 10^{-3}$ m s^{-1}. The second model, reproducing energy transmission through the open boundary, required a coefficient of energy transmission b = 0.063 (implying that 22% of the seiche energy is transmitted through the Otranto Strait). In such a manner maximal values for the two coefficients were determined.

Finally, a numerical model was developed in order to describe damping caused by both mechanisms. The real topography of the Adriatic Sea was taken into account. A series of computations for different possible values of coefficients k and b were carried out. An example of elevations obtained is given in Fig. 1. Using the empirically obtained decay time and values of k which had previously been determined for the Adriatic (ORLIC, 1987) it was possible to estimate values of b. It was found that for k reaching the minimal value detected in the Adriatic (0.5×10^{-3} m s^{-1}) b equals 0.018. In that case 7% of the seiche energy passes through the Otranto Strait. The model allowed the maximal value of $k = 0.74 \times 10^{-3}$ m s^{-1} when, of course, b equals zero and the seiche energy is perfectly reflected back into the Adriatic. It might be concluded that only a small percent of the seiche energy incoming to the Otranto Strait is transmitted to the Ionian Sea. Both the shape and closeness of the Adriatic Sea make the seiches persistent.

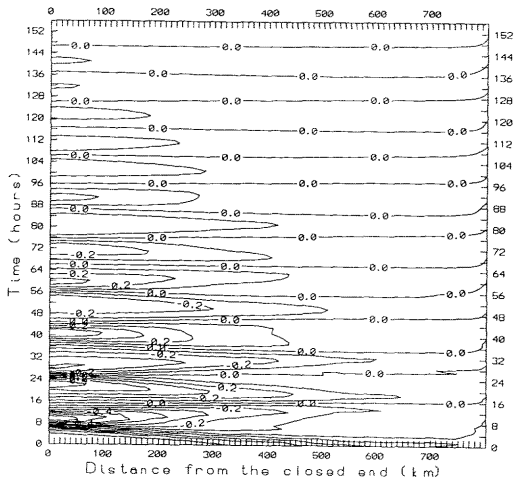

Figure 1. Space-time plot of elevations computed by the numerical model, when the coefficient of bottom friction equals 0.5×10^{-3} m s^{-1} and the coefficient of energy transmission is 0.015. Contouring interval is 0.1 m.

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Rapp. Comm. int. Mer Médit., **33**, (1992).

Some characteristics of the sea water transparency of the Adriatic Sea during the period from 1956 to 1990

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During the oceanographic cruises data on transparency were collected from all the stations in the Adriatic sea during the period from 1956 to 1990. Transparency was measured by Secchi disc (30 cm). The transparency of the Adriatic sea is taken only at stations on the open sea to avoied the irregular variations of the transparency of coastal and channel waters (Fig.1.).

Fig 1. Positions measurements by Secchi disc on the open Adriatic sea

Total data number was devided into two periods, earlier period (1956-1971) and recent period (1972-1990) in table 1.

Table 1. The average of the values of the transparency of the sea water is measured by Secchi disc (m). The figures in brackets denote the number of measurements

Open Adriatic sea areas	Period (1956 - 1971)		(1972 - 1990)	
North	19.4	(150)	13.9	(223)
Middle	26.3	(740)	22.7	(281)
South	27.4	(189)	22.0	(404)
Average	25.5	(1079)	20.2	(908)

Simple statistical data analysis (annual, seasons and monthly average measurement of the transparency values) showes us that for all open sea areas from the north to the south the transparency shows a decrease trend in the recent period (1972-1990) in comparison to earlier period (1956-1971). This trend of decreasing transparency values may be a good predictor for showing us the increasing pollution of the sea water. The increasing of pollution appeared with long and intesive appearance of "red tide" not only in the coastal area but also in the part of the open sea for the period of last few years.

Results of data analysis and comparisons of the both periods will be given in tables and figures.

Also, data analysis shows that average decreasing transparency values for all area on the open Adriatic sea is 5.3 m (20.3%). On the other hand, however, the changes are better pointed out at Fig 2.

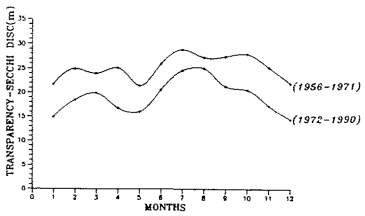

Fig 2. Transparency month-to-month variations at stations for the earlier period (1956-1971) as well as for the recent period (1972-1990)

It is quite obvious that transparency has been reduced for all 12 months for the recent period (1972-1990). Fig 2. also shows that transparency decreases at all stations in May and increase in July or August. The climate origin influences the showen decreasing and increasing of the transparency of the sea in the particular periods and given months is bigest cause of showen values, as well as, the constant seasonal variation of the sea water transparency.

Similar data analysis will be undertaken at the north part, as well as, at the middle and at the south part of the Adriatic sea.

The given statistical data analysis of the sea water transparency despite all the lack of numbers and dispersion can be used as a contribution for the further search of the optical properties of the Adriatic sea.

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Sea level response to atmospheric oscillations on climatic and synoptic periods

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Sea level rise is one of the most disturbing possible consequences of global "greenhouse" warming. On climatic time scale global sea level rise about 10-20 cm/century (BARNETT, 1984) and according to W.R. Peltier (MEIER, 1990) during the past 50 years, sea level has been rising at an average of 2.4 ± 0.9 mm yr^{-1}. On the climate time scale the sea level rises due to CO_2-induced warming, low frequency fluctuations such as ice age e.t.c. This CO_2 increasing might lead to a rise of air temperature and so to a global sea level rise. On the other hand, at shorter time scale (about several days and weeks) sea level variability has been explained in terms of atmospheric pressure forcing which is impossible on climate time scale.

The purpose of this work is to find out:

- how variability in air pressure affects the sea level on climatic time scale and
- what happens with these processes on shorter time scale.

For these purposes yearly values of mean sea level and air pressure for the avaiable period (1890-1987 for Trieste and 1955-1987 for Split) were analysed. Relative values of mean sea level together with seven-year filtered values (PUGH, 1987) are plotted in Fig.1. Trend is evident for station Trieste. Fitted linear model leads to a slope of 0.1376 cm/year which is according to BARNETT value, of 13.66 cm/century (BARNETT, 1984).

In order to study the mean sea level response to the air pressure on climatic time scale, annual mean air pressure for station Trieste was analyzed for the same period as the sea level. Regression analysis between seven-year filtered values of sea level and air pressure data gives regression line with corresponding correlation coefficients (r=-0.28).

Relatively low correlation coefficient in Trieste data can be explained by existing mean sea level increase trend incomparable to far less pressure decrease trend. For station Trieste a linear trend in mean sea level and air pressure was obtained:

$$PRE = 1015.55 - 5.435\ 10^{-4}\ t$$
$$MSL = 150.36 + 0.1376\ t.$$

Detrended series gives a correlation coefficients of r=-0.727.

On the time scale of several days the sea level response to atmospheric pressure forcing was analyzed based of hourly data for station Split. After applying symmetrical 24M214 filter, smoothed curves are obtained (Fig.2.) containing signals of few-day period. Maximum correlation (r=-0.46) was found for lag of 43 hours which is in accordance with the synoptic scale.

In conclusion it may be pointed out that the sea-level changes on climatic time scale are not induced by the atmospheric pressure forcing because the air pressure negative trend contributions can be neglected. On the time scale of several days atmospheric pressure forcing is better pronounced.

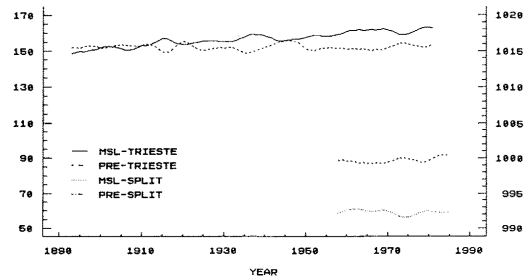

Figure 1. Filtered annual mean sea level and air pressure

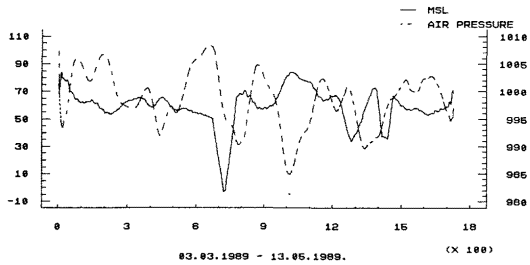

Figure 2. Filtered hourly values of mean sea level and air pressure for station Split

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Seasonal Variability of the Inertial Signal in the Northern Adriatic

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Previous investigations of the inertia-period oscillations in the Northern Adriatic were mostly related to the individual summer events. They were based on measurements carried at various stations over short time intervals (30-60 days). The object of the present investigation was to document seasonal variability of the inertial signal and its decay time. The investigation was made possible by the year-long time series, recently collected in the Northern Adriatic.

We had at our disposal data taken by Aanderaa RCM-4 current meters at two stations in the Northern Adriatic in the period 1988-1990, as well as density measured traditionally at the same stations in the period 1966-1991. Station A was located about 15 NM west of Rovinj (bottom depth -37 m), Station B 15 NM west of Pula (43 m). Current meters were suspended from the subsurface moorings, at the 5, 20 and 30 m depth (station A), and the 5 and 37 m depth (station B). Density was measured at conventional depths.

To isolate the inertia contents of the current-vector time series, seven principal tidal components were synthesized and eliminated. Thereafter, the inertial signal was extracted, by applying a band-pass filter around the local inertial frequency (1/17 cph). The amplitudes thus obtained for different years were pooled in a single year, and were averaged over successive 15-day intervals. Finally, a polynomial was fitted to the data recorded at each particular station/depth.

The resulting curves for the three depths of Station A are shown in Fig. 1. A similar result was obtained for Station B. Maximum surface amplitude (about 10 cm/s) occurs in summer, minimum (< 2 cm/s) in winter. Ratio of amplitudes at the 20 and 5 m depth is minimal (about 0.15) at the beginning of March, and reaches maximum (over 1) in September. This property can be explained using a two-layer fluid model (CSANADY,1973; ORLIC, 1987). In the model the ratio of vertically averaged baroclinic velocities in the surface and bottom layer is equal to the bottom-to-surface ratio of thickness of the two layers. Density data show that stratification is negligible between November and the end of February. During March it begins to develop, with an average pycnocline depth of about 5 m. From March to October the pycnocline deepens to 20 m, which favours an intensification of bottom currents as related to the surface ones.

In order to determine the decay time of the inertia-period oscillations, exponential curves were fitted to the descending segments of the band-passed time series. Only episodes in which amplitudes exceeded 3 cm/s were considered. Decay times were averaged throughout the depth and over the successive 15-day intervals. Results were similar for the two stations: The greatest decay times were obtained for June and July.

The problem of damping of the inertia-period oscillations by bottom friction had been solved using the two-layer model (ORLIC, 1984). Here, the model was extended by introducing interface friction. It was found that the decay time depends on depths of the surface and bottom layers, on the proportionate density defect of the surface layer, as well as on the coefficients of interface (K) and bottom (k) friction. Empirical decay times and density data allowed the model to be inverted in order to determine the two coefficients. This exercise gave K=0.14-10-7 m/s and k=0.73-10-3 m/s. The contribution of interface friction to damping was found to be about 20 % in March and April. It decreases to about 10 % in June, due to stabilization of the water column. From July to October the contribution decreases further (to less then 5%) because the pycnocline then deepens and bottom friction gains in importance.

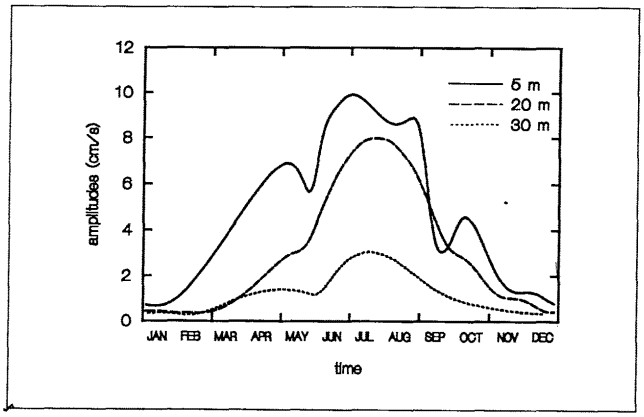

Figure 1. Annual cycle of amplitude of the inertia-period oscillations registered at Station A.

Acknowledgement

Long-term current measurements were organized by Dr J. BRANA. Density data were furnished by the Centre for Marine Research (Rovinj).

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Remotely Observing River Discharge on Shelf - A Case of Wind-provoked Extrusion of Po Waters

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Remote sensing of marine environment offers unsurpassed opportunity of synoptic and frequent assessment of its various properties. Colour of the sea is unique among them in offering, to remote sensing, information from below the surface. Optical properties of near surface waters could be profoundly changed under the influence of river discharges rich in nutrients and/or loaded with dissolved and suspended material. This makes river discharges particularly suitable for remote detection by optical sensors. The fresh water runoff also supplies low salinity waters whose eventual fate is often, to various degree, influenced by prevailing wind regime. MULLER-KARGER *et al.* (1989), for example, have found that the largescale distribution of pigments in the Caribbean Sea seems to be controlled by wind stress, flux of water through the basin and river discharge; the Orinoco river plume dispersal was found tightly coupled to variation in the wind.

The Northern Adriatic into which the Po River discharges offers a case of pronounced river discharge into shallow, coastal waters. Although not nearly comparable to the rivers of previous example (Amazon and Orinoco) Po does supply the largest discharge into the Adriatic. Within the last decade the area was object of several remote-sensing related studies. These studies often dealt with retrieval algorithm development, but remote sensing was also used to aid oceanographic work. BARALE *et al.* (1986), for example, used a time series of Coastal Zone Colour Scanner (CZCS) scenes for the years 1979 and 1980 to study the surface colour field and circulation patterns on monthly and interannual scales, distinguishing coastal and open sea water masses via different pigment levels. It is interesting to note that, on the considered scales, the authors found the wind ineffective regarding the pigment distribution. CLEMENT *et al.* (1987) reported two types of pigment patterns observed on the Adriatic shelf, suggesting also their seasonal behaviour. One type is elongated, trapped along the Italian coastline, and found in winter, whereas the another is wide, irregularly spreading into the basin interior, and appearing in summer. Studying further this dichotomy STURM *et al.* (1992) have recently shown that the two patterns are not necessarily seasonally restricted, i.e. both may occur in summer and winter.

The case of offshore spreading in winter is the one previously reported by KUZMIC (1991) and further considered in present paper. Namely, in winter, as number of papers confirm, the Northern Adriatic is well mixed along vertical and river-affected waters remain confined to the western Adriatic coast. Apparently, this situation can change if certain conditions are met. In particular, is has been suggested and partially empirically verif ied (see e.g. KUZMIC and ORLIC, 1987) that spatially heterogeneous bura wind, known to blow in the area, spins up a cyclonic gyre which carries upwind (towards northeast) the waters from the southwestern coastal strip. Since that is the area into which the Po waters are discharges the gyre could be a mechanism to extrude the turbid and nutrient-rich waters into the basin interior. In order to explore this hypothesis previously developed hydrodynamical model has been augmented with a simple two-dimensional dispersion model. The extension facilitated comparison of model simulations with the remotely sensed data, avoiding at the same time *ab initio* modelling of the near field interactions. Selected CZCS scenes were processed to yield derived field of pigment concentration as well as total suspended matter. Atmospherically uncorrected fields of composite reflectances (the first three CZCS channels) and histogram equalized original channels were also analysed. Rather imperfect infra-red information in channel 6 was consulted when available. The comparison of model-generated and sensor-collected information suggests that the heterogeneous bura wind is indeed capable of provoking Po-water extrusions into the Northern Adriatic interior.

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X

Observation of internal waves in the middle Adriatic Sea

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From 13 to 30 August 1990 Aanderaa thermistor chain TR-7 and two current meters RCM 7 were moored near Lastovo island in the Middle Adriatic Sea at station L-4 (φ = 42° 45.2' N, λ = 17° 08.8'E d = 95 m). Thermistors were at 15, 21, 27, 33, 39, 45, 51, 57, 63, 69 and 75m depth, while current meters at 10 and 80 m. Measurement interval was 5 minutes.

Vertical profiles of temperature, density and Brunt-Vaisala frequency obtained from CTD measurement at the beginning of the measurement period are shown in Fig. 1. A strong thermocline was present between 12 and 22 m as well as pycnocline and Brunt-Vaisala frequency peak. These experimental data are similar to the theoretical assumptions done for discussion of internal waves at the boundary between two fluids of different density (MUNK, 1981). During the measurement period two strong wind episodes were recorded (the first lasting about a day and the second about 3 days).

Power spectra calculated from temperature and current data indicated high internal wave dynamics. Temperature sensor at 10 m depth was for the first 10 days near the top of the thermocline and then, owing to the lowering of the thermocline, in the mixed layer. Wind force generated inertial oscillations (period 16.7 hours) so that the peak at inertial frequency dominated in temperature power spectrum. Furthermore, there are peaks at 9.9, 6.4, 4.7 and 4.2 hour periods of the same order of energy. Approaching from 4.2 hours period to Brunt-Vaisala period the energy of the oscillations becomes significantly smaller.

Similar spectrum shape was obtained for 21 m depth (in the middle of thermocline). Important difference occurred only at inertial frequency where energy at 21 m depth is about ten times higher than at 10 m. At the bottom of the thermocline (33 m), a tidal peak (24 hours) was observed with other peaks. Magnitude of tidal energy is near the inertial one. The shapes of the spectra from 33 m to the bottom were similar to the spectrum at 33 m depth, but with smaller energy. At 45 m depth tidal energy exceeds the inertial one.

Comparing current spectrum at 10 m depth with theoretical Garrett-Munk spectrum (1972, 1975) for deep ocean, the similarity can be seen i.e. experimental spectrum follows ω^{-2} slope for internal wave frequency band (ω is frequency). The higher discrepancy between theoretical and experimental spectra was detected in low internal wave frequency band (periods between 16.7 hours and 4 hours) what can be explained by near-surface proximity of strong sources of internal waves, especially winds and surface waves (ROTH *et al.*, 1981).

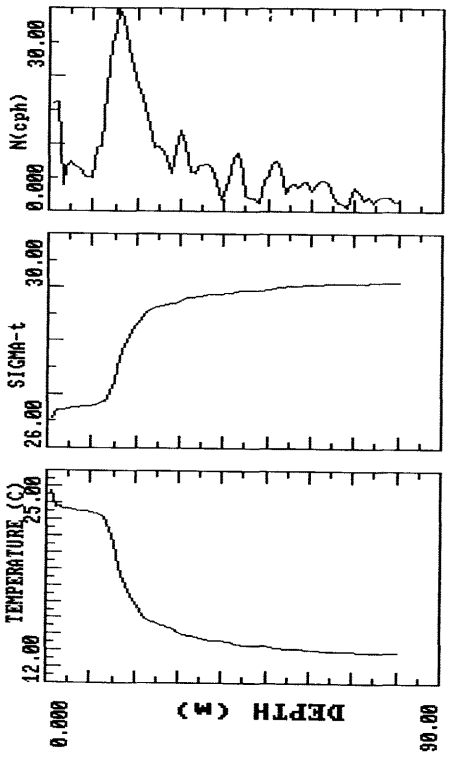

FIG. 1. Vertical profile of temperature, density and Brunt-Vaisala frequency N on August 13, 1990, station L-4.

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On Subinertial Response of the Sea to the Air-Pressure Forcing

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Relationship between subinertial variability of the Adriatic sea level and planetary-scale atmospheric forcing was demonstrated by ORLIC (1983). From high values of coherence squared between sea-level and geopotential height of the 500 mb surface in the low-frequency band (0.1 - 0.01 cpd.), it was concluded that the atmosphere and sea may be approximated by a constant-parameter linear system. In most simulations of response of the Mediterranean Sea to the air-pressure forcing, the modeling area was split in two basins with variables spatially averaged within each of them (e.g. CANDELA *et al.*, 1989). In order to probe dynamics of subinertial atmosphere-sea interaction further, a model of barotropic response of the sea in a channel to travelling air-pressure waves is developed.

Linearized depth-averaged equations of motion and continuity are used to simulate frictionless flow in the f-plane flat-bottom channel. Analytical solution is found for subinertial frequencies (MALACIC and ORLIC, 1992). For the atmospheric wave travelling along the channel whose width is close to the Rossby radius of deformation, model predicts sea levels and currents organized in two coastal waves and geostrophic system in mid-channel (Fig.1). The structure is coupled to the atmospheric wave. The right-hand coastal wave is moving in the direction of the free Kelvin wave, therefore is more pronounced than the left-hand wave. The motion is resonantly driven when phase velocity of the forcing wave approaches Kelvin-wave velocity.

When the atmospheric wave is moving across the channel at a sharp angle, response of the sea is enhanced for phase velocities below those of free shallow-water waves, due to reflections at channel boundaries. For the atmospheric wave that travels at right angle across the channel, resonance is not possible, and sea level undershoots inverted-barometer response. Now, both travelling and standing waves appear in the channel. In the narrow channel limit only standing wave remains, with nodal line in the middle of the channel.

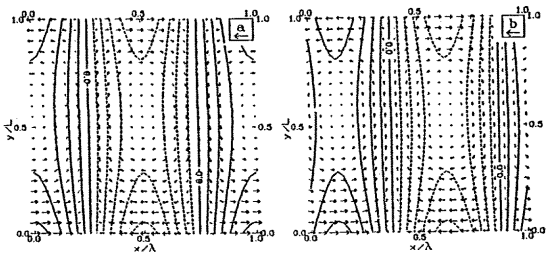

Fig. 1. Elevation contours and velocity distributions for the along channel forcing. The channel width equals $2Ro$ (Ro = Rossby radius of deformation), the channel depth amounts to 10^3m. The atmospheric wave of wavenumber $K = Ro^{-1}$ and angular frequency $\Omega = 0.1\ f$ (f = Coriolis frequency) is moving from the left towards the right sides of plots. Maps are for two instants a quarter of period apart. Solid lines represent positive elevations, while dashed are negative elevations. Contouring interval is interval is 0.2 ξ_0 where ξ_0 - amplitude of the atmospheric wave in sea-level units - equals 10 cm. The velocity scale of ~ 1 cm/s is shown in the frame within each map.

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X

Adriatic thermal front Statistics

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The images from bulletin SATMER published as thermal structures for months were the source of the data. Data set extends from September 1980 to January 1987.

There are some typical position for thermal front. They usually occur parallel to the coast but some transversal transects occasionaly show thermal front. The length of the thermal front extends from one hundred km to 1500 km along Italian coast. To be abble to distinguish the length of frontal zone it is imagined that the front consists of small front increments whose positions were named by the nearest point on the coast. The length of front increments ranged from 50 to 150 km. Fig. 1. shows the positions of fronts.

All front events were counted from every monthly image for each position. There are two types of fronts along the coast : there can be either a positive or a negative temperature gradient towards the coast so they are separately counted while transversal fronts are considered negative if there is a negative gradient towards north.

Fig. 1.- Front positions

The frequencies of the occurence of fronts in every season were presented by histograms in fig. 2.

The highest number of fronts recorded within observed period was 18 negative fronts at positions 3, 4, 5 and 6. Fronts were also frequent at positions 1 and 2 so that in winter it usually had long extension along Italian side.

In the spring their occurence was smaller but still much higher than the occurence of other fronts. In spring also more often than in winter occured fronts of positive gradients at the Italian side of coast. The phenomenon of positive fronts is for Italian side especially characteristic for the summer time while in the same time very few negative fronts occur.

Correlation between all fronts was calculated in order to get more informations about silmutaneous occurence of fronts at different positions.

Different seasonal rhythm was found for fronts along Italian and Albanian side of the coast in some seasons.

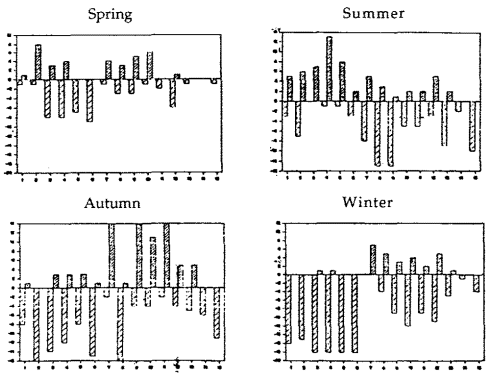

Fig. 2.- Frequencies of fronts

Global climatic fluctuations reflected in the Mediterranean Sea

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Response of the Mediterranean Sea to slow air-pressure changes, especially those caused by planetary atmospheric waves, is being the subject of extensive studies. Here we examine low-frequency variability of the Adriatic Sea, due to long-lasting pulse of high air pressure that was recorded in the Mediterranean area in winter 1988/89.

Persistent, exceptionally low sea levels were registered in winter 1988/89 all along the east Adriatic coast (PASARIC and ORLIC, 1992), as well as in other parts of the Mediterranean Sea (e.g. ANGRISANO, 1989). These low sea levels corresponded with an anticyclonic disturbance over Europe. Monthly mean values of sea level at Bakar and air pressure at Mali Losinj, together with the 30-year monthly averages and standard deviations, are shown in Figure 1. During four months, from November 1988 until February 1989, sea level and air pressure departed significantly from their long-term averages. In January, at the peak of the event, mean air pressure was higher than the January average by more than three standard deviations, and sea level was lower than its average by more than two standard deviations. The ratio of January anomaly of sea level to that of air pressure was close to 1.6 cm/mbar; it suggests that the inverse-barometer overshoot, observed in the frequency range dominated by planetary atmospheric waves, characterizes the longer-term variability as well. The anticyclonic disturbance was of great spatial scale. Monthly charts of anomalies of sea-surface air pressure and geopotential height of the 500-mbar surface show that the high-pressure field spread in winter 1988/89 over the whole of Europe and extended to the higher levels of the troposphere.

Climatic fluctuations over Europe, similar to the one of winter 1988/89, occur from time to time, and have been analysed in a number of empirical and modelling studies. Results show that the European climate is influenced by sea surface temperature anomalies in the northwest Atlantic and equatorial Pacific. Persistent anticyclonic disturbance over Europe can be associated with the colder-than-usual surface water occurring in winter off the coast of Newfoundland (PALMER, 1986). In years when abnormally cold water appears in the equatorial Pacific (the event called La Nina), there are more anticyclonic and less cyclonic situations over Europe; these Pacific cold events peak in December, and the response of atmosphere above Europe is largest the following January and February (FRAEDRICH 1990). It seems that a dual cold event has taken place in winter 1988/89: appearence of abnormally cold surface waters has been registered in both the northwest Atlantic and equatorial Pacific (ARKIN, 1989). This implied strong anticyclonic disturbance over Europe, which in turn caused exceptionally low sea levels.

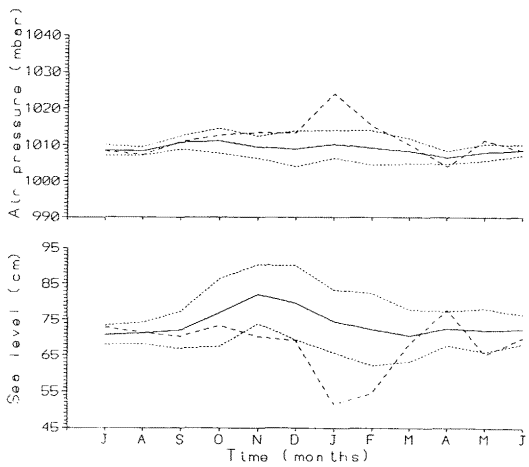

Figure 1. Monthly means of air pressure registered at Mali Losinj, and sea level recorded at Bakar. Full and dotted lines denote the 1956/85 averages and standard deviations, respectively, whereas dashed lines mark the values measured in winter 1988/89.

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The northward flow of Mediterranean water in the Adriatic Sea in the light of oxygen isotope measurements

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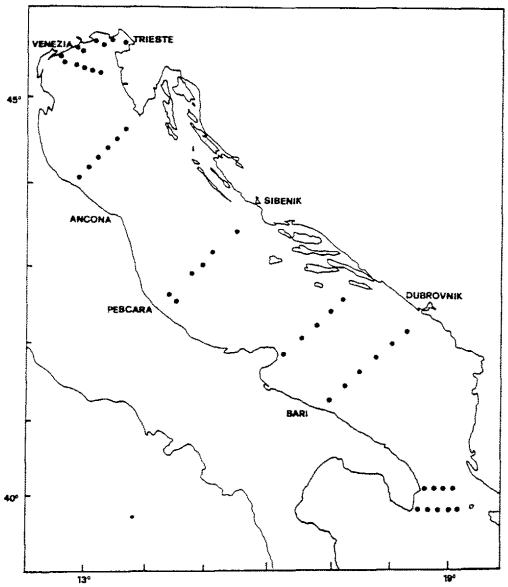
Despite the research work carried out by several authors the Adriatic sea is not yet known in detail from the point of view of circulation and distribution of the characterizing variables like salinity, temperature and density of the water. Our knowledge regarding the distribution of the oxygen and hydrogen isotopic composition of Adriatic seawater and the latitudinal and vertical changes of these variables is pratically inexistent. To start the collection of reliable data in this field we analyzed up to now a few hundred samples of Adriatic seawater from vertical profiles from southern, central and northern Adriatic (Figure 1). For many of these samples other variables (e.g. salinity, temperature and density) are available and were or will be published by other authors. Our isotopic measurements, though largely incomplete, already yielded data which are of importance for a better knowledge of the circulation in this sea. In fact, sets of bottom water samples between Venice and Trieste showed repeatedly $\delta^{18}O(H_2O)$ values ranging from +1,1 to +1,4 per mil (V-SMOW). These are very positive values which drastically differ from those of surface water samples which generally range, in this area, between +0,8 and -0,5 per mil. In this case the depletion in ^{18}O is clearly and obviously due to the inflow of river water whose $\delta^{18}O$ is considerably negative. The range of values goes from about -12,5 per mil in the case of the Adige river to about -10,0 per mil in the case of the Po river to values of about -8 to -9 per mil for other minor rivers in the area. This means that only when a marked cooling of surface water takes place in this area or strong winds increase the dynamic of water masses, a real homogeneization of the different water layers takes place in northern Adriatic, as shown, e.g., by sets of samples collected in the winter period. When, on the other hand, surface warming and/or the absence of strong wind increase the vertical stability of different water layers, no vertical mixing takes place and even diffusion processes seem to be drastically reduced. Under these conditions, bodies of Mediterranean water from the eastern and central basins -characterized by very positive $\delta^{18}O$ values- may apparently flow all the way to the northernmost section of the Adriatic sea as a thin bottom layer. Despite a course of hundreds of kilometers this bottom water layer, under favourable conditions, may largely preserve its original isotopic composition through time and space. In fact, eastern and central Mediterranean are the only sources of isotopically positive water wihch may explain the most positive values obtained. The northward evolution of the $\delta^{18}O(H_2O)$ values from the Otranto channel and the dynamic of the Adriatic water masses are discussed in some detail on the basis of the isotopic values obtained and their comparison with other classical variables measured in seawater.



An estimation of surface heat flux over the Northern Adriatic

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Heat exchange between the atmosphere and sea plays an important role in the Northern Adriatic dynamics. In this note preliminary results of the surface heat flux evaluation at three stations in the region are presented.

Monthly means of conventional climatological data (air pressure, air temperature, wind speed, cloud cover, specific humidity, precipitation) and sea surface temperature were used to compute monthly averages for the period 1966 - 1971 at stations Trieste, Rovinj and Mali Losinj. Total downward heat flux was determined from:

$$Q = Q_s - Q_l - Q_e - Q_c$$

where Q_s is the absorbed global solar radiation, Q_l is the net longwave radiation, Q_e is the latent (or evaporative) heat flux, and Q_c is the sensible heat flux. Terms Q_l, Q_e and Q_c were computed according to GILL (1982). Q_s was computed using theempirical relation (PENZAR and PENZAR, 1991):

$$Q_s = Q_{s0} (1 - (1 - a) N) (1 - \alpha)$$

where Q_{s0} monthly average of the clear sky radiation, is corrected for the cloud cover N and reduced with an albedo $\alpha = 0.08$. Term a represents an empirical coefficient.

Figure 1 shows annual cycle of total heat flux into the sea, at three stations in the Northern Adriatic. The sea gains heat in the warm period, from March/April to August/September. This compares well with the results obtained by COLACINO and DELL'OSSO (1975), but not with those published by STRAVISI and CRISCIANI (1986). There is a maximal heat gain in May or June, whereas the maximal heat loss occurs in December at all the stations.

At Trieste and Mali Losinj the sea loses heat with an annual mean surface flux of 17.7 and 30.1 W/m^2, respectively. Conversely, annual mean heat gain is observed at the Rovinj station (25.9 W/m^2). At all the stations Q_s has an annual mean value of about 120 W/m^2, annual mean Q_l is everywhere close to 70 W/m^2, whereas annual mean Q_c range between 5 (Rovinj and Trieste) and 11 W/m^2 (Mali Losinj). The difference between the total annual mean flux at three stations arises mainly from different amount of heat lost by evaporation. At Rovinj Q_e averaged over the year is only 26 W/m^2, at Trieste 55 W/m^2, while at Mali Losinj it amounts to 72 W/m^2.

Difference between total annual precipitation (about 1 m at all the stations) and evaporation has also been evaluated. The precipitation prevails over evaporation everywhere: the annual mean difference is 146 mm at Mali Losinj, 292 mm at Trieste and 584 mm at Rovinj.

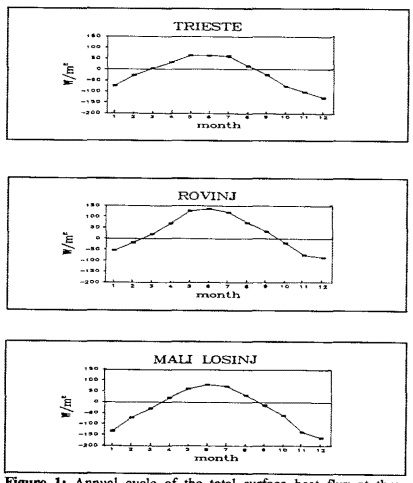

Figure 1: Annual cycle of the total surface heat flux at three stations in the Northern Adriatic.

Acknowledgement

Data were supplied by the Hydrometeorological Institute of the Republic of Croatia (Zagreb) and Istituto Sperimentale Talassografico (Trieste).

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X

Chernobyl derived radiocesium in marine sediments near the Po River Delta

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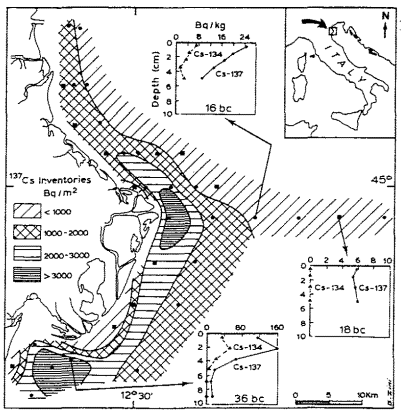
In this paper we discuss sources, concentration and distribution of Chernobyl derived radiocesium in sediments near the Po River delta, in order to establish its usefulness as a tool for studying marine processes, in particular water-sediment interactions, particle transport and distribution. Presently ^{137}Cs is widely used as a stratigraphic marker for determining the extent and rate of sediment accumulation and mixing, especially in conjunction with ^{210}Pb. Nevertheless, many aspects of cesium behavior in the Adriatic coastal environment are still unclear.

Sediment from 35 box cores were collected in July 1987, exactly fifteen months after the accident, at the locations shown in the figure. Sediment was sliced at intervals of 1-3cm, with greater detail in the upper part of the column. Dried material was analysed by gamma spectrometry to obtain ^{137}Cs specific activity. Complete profiles for both ^{137}Cs and ^{210}Pb were measured in thirteen gravity cores (FRIGNANI and LANGONE, 1991; STICCHI, 1990) with the purpose of determining mean accumulation rates for different sites around the delta.

The $^{137}Cs/^{134}Cs$ ratio determined was 2.9-5, compared with respect an original value of 1.9 and a theoretical value of 2.8 after 15 months. Obviously, the highest ratios are typical of samples with a low content of Chernobyl cesium and a significant contribution of the "old" ^{137}Cs. In order to calculate the inventories, a correction was made based on the content of ^{134}Cs and the knowledge of ^{137}Cs activities before Chernobyl, so as to obtain the Chernobyl ^{137}Cs from the measure of the total activity.



Sediment dispersion in the area shows a pattern determined by the cyclonic water circulation system of the Adriatic sea, which causes a prevailing transport southwards. Fine sediments are mostly deposited in 8-30m deep bottoms in the southern part of the study area. In the figure, samples with different lithology are indicated using different symbols (•, mud; ▮ muddy sand).

^{137}Cs activities in surficial samples range between 6 and 285 Bq/kg, whereas ^{134}Cs values range from the undetectable to 95 Bq/kg. The figure shows the distribution of inventories, which is very similar to the concentration pattern of the two isotopes. Maximum values are found close to the river mouths of Po delta Pila and Po di Goro, where the materials from these distributors are first deposited. A relatively high concentration is also shown in sediments collected offshore the mouth of the Adige River. Minimums are characteristic of coastal sands and of muddy sands offshore. These results once again confirm that the ^{137}Cs in these coastal sediments was transported by the river from land.

^{137}Cs activity-depth profiles are of three different types (see figure). The ^{137}Cs activities in sample 36bc (type 1) show the typical trend of sediments with relatively high accumulation rates. This is characterized by a sharp peak at 1.5-3cm depth. In all stations with such typical trend a new layer of sediment with a lower cesium concentration was deposited a~er the first contaminating input. In station 36 an apparent accumulation rate in the order of 1.8cm/yr. can be calculated. This value is fairly consistent with a more precise determination previously made on sediments from the same zone (FRIGNANI and LANGONE, 1991). The profile of sample 16bc (type 2) shows a quasi regular decrease from the surface maximum to the pre-Chernobyl value within the first 6 cm. This sample was collected from the distal portion of the Po river prodelta (low sediment accumulation), but the same shape is shown by coarser sediments near the shore. In all these cases the major input of radionuclide is still confined at the sediment-water interface but some downward transport has occurred. This transport can be due either to bioturbation or physical mixing. Penetration of Chernobyl cesium deep into the sediment varies in the area from 0 to about 8cm. The last type is that of box 18bc which as no ^{134}Cs and low and constant values of ^{137}Cs. This means that this sediment did not record the contaminating event, probably because of the very low sedimentation at this site. An erosion event could Ave removed the very low input before sampling. Other intermediate situations with a very low content of Chernobyl cesium were found.

The values of ^{137}Cs inventories are comprised between 338 and more than 16500 Bq/m2. BATTISTON *et al.* (1988) reported a flux from the atmosphere value of about 3500 Bq/m2 for inland stations in Padua for May 1986. We can assume this value as representative for the fallout input over the sea surface, even if we know that rainfall is lower in marine areas. As seen in the map, only four samples show values higher than 3000 Bq/m2. Therefore, since the activity and inventory distributions underline that, in some places, most of the cesium is of riverine origin, transfer from the atmosphere to the sediment is not efficient. This could imply that the interaction between cesium and particles in the marine environment is slow and scarcely efficient.

In a previous paper, FRIGNANI and LANGONE (1991) discussed areal and vertical distribution of radionuclides in NW Adriatic coastal sediments, showing a behavior of ^{137}Cs which seems dominated by river inputs rather than by fallout deposition. The quantification of these phenomena is far from being achieved. It is not even clear, yet, the influence of diffusion and mixing in the formation of the activity depth profile in the sediment. Regarding these problems tentative estimates can be proposed to contrast river input and fallout deposition, and suitable models for the distribution of a pulse input in the sediment column, together with Kd data, are to be used to understand the relative importance of mixing and diffusion on the formation of the activity-depth profile.

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CS-137 and I-131 Distribution in lagoonal and coastal environment of Northern Adriatic

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Radioecological investigations performed in Marano and Grado Lagoons in the years following the Chernobyl accident pointed out the presence of artificial radionuclides in coastal and lagoonal areas of Friuli-Venezia Giulia Region (BELLI *et al.*, 1989). The authors have started a multi-annual program for the monitoring of environmental radioactivity in Northern Adriatic, in order to evaluate the diffusion of artificial radionuclides in areas close to coasts and lagoons between Grado and Punta Tagliamento. This program involves a number of samplings of environmental matrices (superficial sediments, algae, filter feeder, mollusks, macrobenthos, ichtyic fauna) in different seasons. In order to evaluate contamination deriving from Chernobyl accident, Cs-134 and Cs-137 were examined while the evaluation of pollution deriving from medical environment was evaluated through I-131.

40 sampling sites were chosen to determine the main pathways of diffusion of those polluting agents. Some of them were in the final tract of rivers, some in the Lagoons themselves and finally in the marine areas close to lagoonal ores and to Tagliamento and Isonzo mouths. In this preliminary work we report the results obtained from the samples of superficial sediments and algae (Ulva and Gracilaria) collected in the period December 1991-May 1992. Gamma spectrometry was performed on 40 samples of sediments and 41 samples of algae ; radioactivity data were referred to May, 5th 1992.

Figure 1 shows Cs-137 (Bq/kg d.w.) concentrations in samples of sediments. Results allowed to discriminate the following areas :

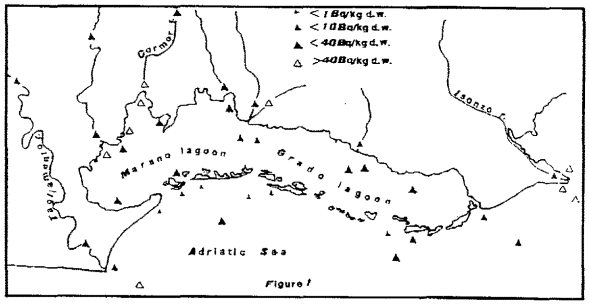
- river mouths : in these areas the highest concentrations of Cs-137 were detected (Isonzo : 88.1 Bq/kg d.w.; Cormor 74.9 Bq/kg d.w.; Tagliamento 51.8 Bq/kg d.w.), confirming the considerable role played by rivers in the distribution of radiocaesium in the marine environment ;
- Lagoons : higher concentrations were detected in the Marano lagoon, which has more river contributions and lower water exchanges in comparison with Grado lagoon ;
- marine area close to lagoonal ores : this area shows the lowest absolute concentration, ranging from 0.1 Bq/kg d.w. at the lagoonal ore of Primero ;
- external marine area : in this area high values were again detected (up to 69.5 Bq/kg d.w.).

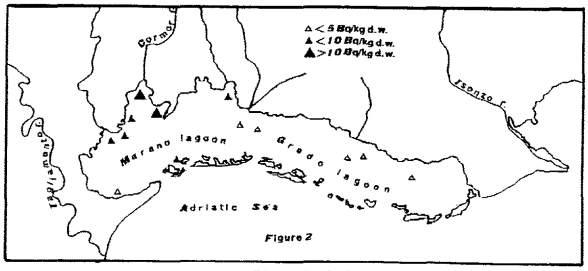
Figue 2 shows I-131 concentration values in Ulva samples. In the western part of the Marano lagoon, in correspondence with mouths of the rivers Stella and Cormor, the highest values of I-131 concentrations were detected. The concentration decreases toward Grado lagoon and lagoonal ores.

Based on the experimental results, the following conclusions can be drawn :

- rivers are the major responsible for transport and distribution of radionuclides in marine environment, as well as for heavy metals, nutrients and micro-organisms. lagoonal environment is quite complex, thus the comprehension of the dynamic of diffusion of pollutants is rather difficult. However, the radionuclide distribution showed in figure 1 practically overlaps with that of some heavy metals analyzed in the same areas (MATTASSI *et al.*, 1991) ; this observation allows the conclusion that radionuclides follow analogous diffusional pathways ;
- Algae are confirmed as biological indicators of radionuclides as well as of conventional pollutants. these matrices allowed to detect the contamination from I-131 at the mouth of the rivers Cormor and Stella, which convey waters coming from Udine and towns nearby.

Monitoring of marine environment thus confirms its validity as an indicator of trace pollutants.





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X

Radioactivity in sediments along the coast of Albania

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Studies on the radioactivity of sea-bed sediments were carried out in Albania in the bays of Durres, Treport and Porto-Novo. The aim in the case of Durres Bay was to study the in-filling of the port channel. The studies in the bays of Treport and Porto-Novo were concerned with the construction of a new port in the Vlora Bay (1,2). The natural radioactivity measurements were made in order to construct maps of the lithology of the sea-bed of these areas and to draw possible conclusions about the movements of the sea-bed sediments. Maps of the natural radioactivity give the mean effect of the action on the sediments by hydrometeorological elements over a period of several years. Changes can be distinguished within a distance of several kilometers to several hundred kilometers. This work was the first phase of radionuclide studies which aimed at understanding the mechanism of the movement of sea-bed sediments and, at the same time, to discern the quantity and the direction of their movements.

From a large number of sea-bed samples, the granulometry of the sediments was determined. Later, a dynamic survey of the total gamma radioactivity of the seabed sediments was also carried out. The probe (NaI[Tl], d=3.8 cm, h=2.5 cm), fixed on a sled 5 cm above the sea-bed, was towed by a boat at a speed of 1m/s.

The results from a large number of measurements (902 in Treport Bay) were plotted on probability paper. Both in the case of the Durres Bay and Vlora Bay, the points were not regularly distributed around the median value. As a first approximation, one can discern three groupings that seem to correspond to different contents of clays in the sediments (Table 1). Note that for our probe and geometry, the pure siliceous sand gives 12 cps.

Table 1. Total gamma radioactivity (count per second) in sediments from the Albanian Bays.

Family	Durres Bay Percent	Durres Bay Med.±1σ, c/s	Treport Bay Med.±1σ, c/s	Porto-Nova Bay Med.±1σ, c/s
I	25	18.9 ± 0.8	11.9 ± 0.9	12.8 ± 1.8
II	60	21 ± 0.85	15.3 ± 1.5	18.8 ± 3.8
III	15	24 ± 0.8	20.4 ± 1.4	25.5 ± 2.5

The following conclusions were made :

A. Durres Bay

1. The sediments of the bottom represents a mixing of sands (60-70%) with a median grain size of 70 µm and clay (30-40%, with a mean diameter of 2-3 µm).
2. The zones of clay accumulation were determined from lesser depths to depths of 10 m not only in the channel but in the outer parts.
3. The vast clay-like stocks are sufficient to fill in the channel many times over without any need to import clays from the outer areas.

B. Treport Bay

1. According to the above-mentioned groupings, the sea-bed can be divided into three zones. The first extends to depths of 7-8 m. The sediments here are more than 80% sands (d>100 µm, mainly 100-200 µm). The second zone extends from that depth to 10-11 m. The sediments here contain sands (60-80%, d<100 µm). Beyond these depths is the third zone with material that is mainly alevrolite and clay.
2. Generally, the boundaries between these zones follow the isobaths. There are no zones of high radioactivity in the areas with generally lower radioactivity. Therefore, there are no clay-like areas in the sand media. This fact indicates that the wave action has resulted in a good selection of granulometry.

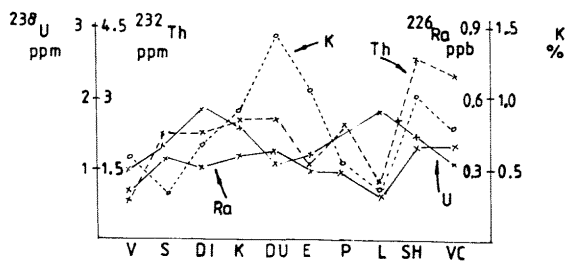
C. Porto-Nova Bay

1. The first zone extends to 8 m depth and consists of pure sand. The second zone extends from that boundary to depths of 12-13 m. In the third zone at greater depths, clay-like sediments are found.
2. The western wave action has also resulted in a good selection of granulometry.

The distribution of U-238, Ra-226, Th-232 and K-40 nuclides in the coastal sediments are especially interesting for understanding the local sedimentology and geology. Not having the possibility to undertake a full-scale study, short-term sampling was carried out with the aim of obtaining limited data and drawing some conclusions about the distribution of these nuclides in the coastal zone. The results of 28 sand samples collected from 10 beaches are given in Fig. 1. The measurements were made with a Hp-Ge detector and the overall errors are 20-50% (U238), 5-8% (Ra-226), 5-10% (Th-232) and 2-5% (K-40).

The suspended sediment samples taken from Vjosa Seman, Shkumbin and Erzen rivers were analyzed for Cs-137, U-238, Th-232 and K-40. The mean values were 4.6, 25, 32, and 360 Bq/Kg respectively. It should be noted that the mean activity and typical range of U-238, Th-232 and K-40 activities in soils is 25 (10-50), 25 (750) and 370 (100-700), respectively (3). Our rivers every year transport in suspension to the sea about 50 million tons of sediments ; therefore, about 200 GBq Cs-137, 1200 GBq U-238, 1600 GBq Th-232 and 28000 GBq K-40 are entering Albanian coastal waters every year.

Fig. 1. Natural radioactivity of different sands from the Albanian coast.



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X

Transfer of artificial radionuclides through the Adriatic food-web

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Organisms and sea water were sampled in different areas of the northern and central Adriatic Sea from May 1986 to December 1987. The areas surveyed were the Gulf of Trieste, the Gulf of Venice, the coastal zone near Ancona and the western part of the "Fossa di Pomo".

Organisms and the water samples were prepared and analyzed by Ge-Li gamma spectrometry. In sea water only radiocesium was determined. On the other hand, several radionuclides from the Chernobyl fallout were determined in pelagic and benthic organisms belonging to different trophic levels of the Adriatic food-web.

The impact of the Chernobyl accident was more relevant in the northern Adriatic than in the central region; in fact, at the beginning of May 1986, the Cs137 concentration in sea water was about ten times higher in the Gulf of Trieste than near Ancona. In a similar way zooplankton, *Sardina pilchardus* and *Mytilus galloprovincialis* collected simultaneously in both zones, displayed different levels of radiocontamination (TASSI PELATI and ALBERTAZZI, 1986).

After May 1986, the variety of radionuclides in the organisms had greatly decreased; nevertheless, for several months it was possible to determine Cs137, Cs134, Ru103, Au106 and Ag110m (TASSI PELATI *et al.*, 1987). A significant decrease of Csl37 and Csl34 in sea water was observed during the winter months of 1986 and the first months of 1987 after the pycnocline broke down and the water masses became mixed. In the zooplankton there was also a quick decontamination because of the excretion processes and resultant element turnover (TASSI PELATI *et al.*, 1987). The rapid removal of Chernobyl fallout from surface waters by zooplankton activity was also observed near Corsica (FOWLER *et al.*, 1987).

It has been noted that, in the transfer to planktivorous fish such as *Sardina pilchardus* and *Engraulis encrasicholus*, the variety of the radionuclides was greater in the viscera than in muscle tissue; moreover, the radiocesium was transferred from viscera to muscle to a greater extent than radioruthenium. The distribution of Csl37 and Csl34 concentrations in *Sardina* and *Engraulis* has been studied in detail on samples collected every two months, from June 1986 to December 1987, in the Gulf of Venice. It has been established that *Sardina* accumulates more cesium than *Engraulis*. In both these species Csl37 was distributed in the following way: 60% in muscle, 15% in viscera, 25% in the head and internal skeleton (TASSI PELATI *et al.*, 1989), a distribution in good agreement with the literature (COUGHTHREY *et al.*, 1985). Among the samples of the mussel *Mytilus galloprovincialis* from the different zones (Trieste, Venice, Ancona), those collected in the Gulf of Trieste near the mouth of the Timavo River were more contaminated than the others. Ru103 and Ru106 were more concentrated in the mussels than Cs137, Cs134 and Ag110m (TASSI PELATI *et al.*, 1987).

As expected, the littoral species in the Gulf of Trieste contained the highest levels of fallout. In fact, a typical rocky shore community *Enteromorpha, Fucus, Patella*, immediately after Chernobyl, contained the greatest number of radionuclides and the highest concentrations (TASSI PELATI and ALBERTAZZI, 1986). Concentrations decreased in the transfer from seaweeds to the limpet. This intertidal biocenosis was studied from 1986 to 1987 and the resulting radiocesium and radiosilver trends are noteworthy. For example, *Fucus* concentrated less cesium but more silver than *Enteromorpha*, and *Patella* contained concentrations of silver higher than those in the seaweeds upon which it feeds (TASSI PELATI *et al.*, 1992).

The phenomena which occurred in the Adriatic littoral community after Chernobyl has also been observed in biota from the British coast (CAMPLIN *et al.*, 1986).

Finally, for organisms from the coastal area near Ancona and the "Fossa di Pomo", it was possible to observe the different concentration capability for Csl37 in some species of fish in relation to their habitat and to their position in the food-web. For instance during 1986 in predator fish such as *Merluccius merluccius*, Csl37 concentrations were lower than in planktivorous fish like *Sardina*, while in 1987 the opposite was true. This clearly shows the usefulness of following the transfer of the most persistent contaminants in the longer-lived organisms which form the terminal steps of the marine food-web.

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Distribution of artificial radiocontamination in the Northern and Middle Adriatic Sea (1989-1990)

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Radioactive fallout from the Chernobyl accident offers an opportunity to study physical-chemical and biological processes influencing the transport of surface-introduced contaminants in the marine environment (1). The direct impact of Chernobyl fallout on the Mediterranean Sea has been investigated in the past by several authors (1, 2, 3). All sampling has been conducted during seasonal oceanographic cruises executed within the ASCOP (Adriatic Scientific Cooperative Programme) and NADEX (Northern Adriatic Delta Experiment) programmes on fixed stations bordering both the Italian and Yugoslavian territorial waters. The ASCOP 13, 14, 15, 16 and NADEX cruises have been managed by mixed Italian and Croatian researchers on board the Italian vessels BANNOCK and LO BIANCO, owned by the National Research Council, and on the Croatian ship VILA VELEBITA, owned by the Ruder Boskovic Institute for Marine Research.

The results highlight the distribution of cesium radio-isotopes in different abiotic comparts and at different levels of the trophic web, and allow making a complete assessment of the Chernobyl-derived radiocontamination after four years of intense and extended monitoring of the Adriatic ecosystem.

Methods

Sampling methodologies and radio-analytical techniques are reported in detail in papers published elsewhere (3, 4, 5).

Results and discussion

Ranges of concentrations of Cs-137 and Cs-134 are reported in Table 1. Sea water samples (25, 50 or 100 l) show a progressive decrease of activities over time due mainly to the high dilution capacity of the water mass and its hydrodynamic properties. It is noteworthy that concentrations very similar to pre-Chernobyl values (6) have been detected since August 1989 and those concerning Cs-134 during the same period are lower than the detection limits. A single exception was noted at St. 108 in August 1989 which showed slightly higher activity of Cs-137 (8.44±1.41 Bq/1000 l) at 15-30 meter depth, probably a result of the strong influence of the current approaching from the Po delta rich in contaminated silt and organic particles.

Cs-137 and Cs-134 concentrations measured in mixed plankton samples reflected the same kind of decrease demonstrated for sea water. This is a result of the short life cycle of the planktonic organisms and by their concomitant rapid element times. Nevertheless, it is noteworthy that Cs-137 trends in mixed plankton are correlated with the biomass present, i.e., higher concentrations have been detected in samples collected during periods of high production.

Activities in benthic macrofauna are higher than pre-Chernobyl values in all samples analyzed. Even radiocesium concentrations detected in filter feeders such as *Chlamys* and *Pinna* are higher than those measured in *Mytilus* at the time of the Chernobyl accident. Considering this, a comparison between mussels and *Chlamys* indicates a higher general cesium uptake and bioaccumulation in the clam living in deep, soft, muddy substrates where particle availability is great, rather than in the bivalves living at the surface and in intermediate waters.

Since radionuclides are concentrated by physical mechanisms as well as by biological ones, some fine sediments have been examined at two different levels to determine the radiocesium flux in this abiotic compartment. The relative degree of cesium contamination is a reflection of the clay properties of sediments which maintain high concentrations of this radiocontaminant. For this reason, high concentrations of Cs-137 (18.1±0.91 Bq/Kg dry) have been detected even on the June 1990 cruise at stations facing the Po delta (St. 108 and 201) which is very rich in silt, clay and loam. Furthermore, all surface sediments (0-3 cm) collected during the same cruise (June 1990) seem to be more contaminated by Cs-137 than strata at 12-15 cm and less contaminated than those at 3-6 cm. The Cs-134 radio-isotope was last detected in samples collected during the August 1989 cruise, falling below the detection limits in the subsequent ASCOP oceanographic campaigns. During the August 1989 campaign, Cs-134 was measured with activities around 1.19 Bq/Kg dry in the surface and with concentrations ranging between 0.79 and 1.11 Bq/Kg dry in the 3-6 cm stratum. No Cs-134 was detected in the 6-9 cm level. Therefore, the flux of Chernobyl-derived Cs-137 and Cs-134 in August 1989 apparently reached a depth of 5-6 cm in the sediment core due mainly to percolation and sedimentation of the suspended matter sinking from above.

TABLE 1 Ranges of concentrations of Cs-137 (1st line) and Cs-134 (2nd line).

Sample	ASCOP 13 Aug.89	ASCOP 14 Oct./Nov.89	NADEX May 90	ASCOP 15 June 90	ASCOP 16 Aug.90
Unfiltered Sea water (Bq/1000 l)	3.41-8.44 <1.60	4.29-5.67 <1.48	3.36-4.88 <0.64	3.05-3.44 <0.73	No Samples Available
Mixed plankton Surface trawl (Bq/Kg wet)	0.27-0.93 <0.48	0.27-0.35 <0.52	No Samples Available	No Samples Available	0.07 <0.05
Soft bottom Macrofauna (Bq/Kg wet)	0.74-1.23 <0.38	No Samples Available	No Samples Available	No Samples Available	0.70-1.12 <0.22
Sediments 0-3cm Box corer (Bq/Kg dry)	1.86-8.79 1.19	No Samples	No Samples	1.07-18.1 <0.50	No Samples
Sediments 6-15cm (Bq/Kg dry)	1.35-4.85 0.79-1.11	No Samples	No Samples	0.50-8.54 <1.0	No Samples

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Macro and meiobenthic responses to oxygen depletion in the Gulf of Trieste (Northern Adriatic Sea, Italy). Preliminary results

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Previous researches carried out in the 70ies showed that some areas of the Gulf of Trieste suffer periodic hypoxic and anoxic crises. Then in 1986 began a research program in order to discover causes and consequences of oxygen depletion on the benthic communities (ALEFFI *et al.*, 1992 in press).

During 1990 and 1991, within the Alpe-Adria Project, grab macrobenthic and corer meiobenthic samples have been collected on three stations. In this paper are considered the results of the station located in the middle of the Gulf, that usually presents, at the end of the summer, low oxygen levels. This station (45°39'80 N, 13°35'40 E) is 22.5 m deep and characterized by sandy pelitic sediments (BRAMBATI *et al.*, 1983). The macrobenthic fauna belongs (according to PERES et PICARD, 1964) to the VTC biocoenosis with DC and DE elements (OREL et MENNEA, 1969). This area, since the end of August to September 1990, suffered anoxic stress accompanied by mortalities of benthic organisms. In the 1991 the oxygen level lowered gradually during the summer, reaching a minimum in October (Fig.1) but mortalities were recorded only in a near deeper area (BRIZZI and VIO, pers. comm.). The analysis of the macrobenthic samples shows a decrement in species and individuals numbers after the crisis of September 1990 (Fig.2). Further depletion in species number was discovered in July 1991 but the individuals number increased. In November 1991 a greater number of species and individuals was observed, indicating a probable recovery of the system. During all the considered period the more abundant species were *Corbula gibba, Maldane glebifex* and *Eunice vittata*, that seem so coping with low oxygen levels. These species also became greater in number, lowering the Shannon index (H) till November 1991 (Fig.2). On the other hand *Amphiura chiajei* and the other less abundant Echinodermata disappeared after the anoxic event of September 1990, confirming a lesser resistance of these animals to this stress (STACHOWITSCH, 1991).

The meiobenthic fraction (only major groups were counted) followed the macrobenthic trend in relation to the number of sampled specimens. In fact, after the anoxic crisis in 1990, the abundances dropped except for the increase of Nematoda (Fig.3), while in 1991 the whole community was reduced in number.

Finally the chi-square test calculated on the distribution of the three more abundant macrobenthic species showed highly significative differences among the four samples (Tab.1). In the same way the distribution of individuals in the major meiobenthic taxa (Nematoda and Copepoda), sampled before and after oxygen depletion in the two years, was significantly different (Tab.1).

Then the oxygen level seems to be one of the main factors influencing the evolution of both macro and meiobenthic fauna.

	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.
1990	4.65	4.09		0.37	4.70	
1991	4.37	2.63	2.20	1.63	1.28	5.35

Tab. 1 - Bottom oxygen level

	3/90	9/90	7/91	11/91
H	3.573	3.088	1.398	2.195
H max	5.392	4.644	4.170	5.087
specimens	300	145	430	463
species	42	25	18	34

Tab. 2 - Diversity

6/90	7/90	9/90	10/90	6/91	7/91	9/91	10/91	11/91
2.03	3.26	7.13	26.77	11.69	7.51	4.57	2.74	7.93

Tab. 3 - Meiobenthos - Nematoda/Copepoda ratio in 1990-1991

Macrobenthos	Meiobenthos
3/90 vs 9/90 = 33.07** 2 dgf	9/90 vs 10/90 = 76.33** 1 dgf
3/90 vs 7/91 = 42.99** 2 "	10/91 vs 11/91 = 124.72** 1 "
3/90 vs 11/91 = 14.43** 2 "	10/90 vs 11/91 = 71.90** 1 "
9/90 vs 7/91 = 130.8** 2 "	
9/90 vs 11/91 = 83.01** 2 "	* = p< 0.01
7/91 vs 11/91 = 11.64 * 2 "	** = p< 0.001

Tab. 4 - Chi-square values between samples

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Living benthic foraminifera in Po Delta River (Italy) : a research in progress

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In this paper we present a lagoon foraminiferal study in progress in the Istituto per la Geologia Marina-CNR, Bologna. Six stations in one of the Po Delta lagoon (Sacca del Canarin) have been selected and sampled at spring-fall time and at autumn-fall time during 1991. The samples have been collected by a Van Veen grab. On surficial and bottom waters the measured parameters were pH, salinity, temperature, Eh, O_2. Their values do not show significant variations, whereas the microfaunas vary quantitatively from one station to another the stations; therefore other parameters, such as $CaCO_3$ and nutrients content, should be responsable of these differences.

The uppermost one cm has been sampled and directly stained with a Rose Bengal/ethanol mixture. In laboratory the samples were washed and replaced in ethanol. Foraminifera were determined under a light microscope: 300 specimens (stained and not) were counted to gain the total population, then the count continued only for living (=stained) Foraminifera until 300 where possible, to obtain the living population; their frequencies are reported in Fig. 1. Because of the scarce availability of data, only the following general valuations can be proposed:

a) noteworthy differences are often present between living and total populations (e. g. St. 3 and St. 4 at spring-fall; St. 4 at autumn-fall). For each station the living/total ratio was calculated and reported in Fig. 1. The range of these values varies from 0 to 0.54. This fact is coerent with data reported in literature (SCOTT and MEDIOLI, 1980)

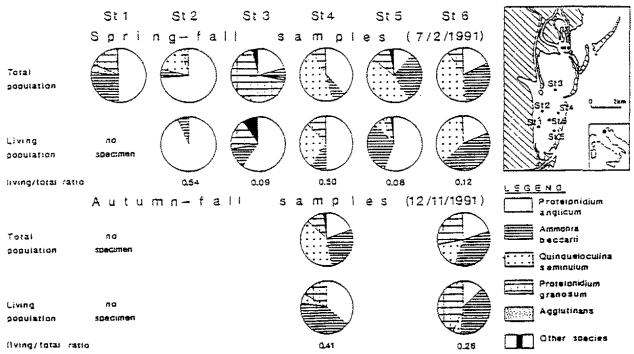
b) there is a strong quantitative difference in the living populations collected in the different stations; they may indicate lateral changes of some parameters at short distance also

c) at this moment of the research, it is hazard to compare the two seasonal samplings; the living populations vary quantitatively in the same station (e. g. St. 4: in autumn-fall, *A. beccarii* frequency increases in comparison with the spring-fall sampling. At the contrary, *Q. seminulum* shows a strong decrease). This fact may be due to environmental instability tipical of a lagoon.

These preliminary results encourage to continue this study wich looks to be pioneer in Adriatic sea. In fact the only study comparable with the present one, is related to Gulf of Trieste (HONEGGER *et al.*, 1989), but it differs in the methodology.

We intend to continue the seasonal sampling in order to obtain two main results:

1) to investigate the present environment
2) to recognize the changes induced by human activity
3) to reconstruct paleoenvironmental situations in Northern Adriatic Holocene sedi-ments.



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Some Different Aspects of *Cystoseireta* in the Northern Adriatic Sea

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Following studies on transformations of the Northern Adriatic underwater flora and vegetation, associations of genus *Cystoseira* which group together species gifted with a considerable polymorphism and with a great adaptability within the incidence of environmental factors have been examined.

The aim of this work is to gather every possible manifestation of such incidence on diversity, in terms of space and time, of Northern Adriatic *Cystoseireta*, and to characterize eventual quali-quantitative gradients of adaptability from the comparison among sampling sites in the Gulf of Trieste: 1. Miramare; 2. Aurisina 1; 3. Aurisina 2; 4. S. Bartolomeo and some sampling sites of the vicinity of Rovinj, Istrian Coast; 5. Val di Corrente; 6. Faborsa; 7. Bagnole Isle.

The site number 8., Salvore, has been chosen because it represents a transition zone between the Gulf of Trieste and the Istrian Coast, but because of the circumstances it was possible to have only summer samplings.

Phytosociological surveys were carried out by the modified Braun-Blanquet method (BOUDOURESQUE, 1971), in which covering values are expressed according to a scale from 0 to 100. The data recorded were set out in synoptic tables with species and surveys; data elaboration were carried out by means of multivariated analysis (automatic classification and ordination).

In terms of space, on biotic bases the results obtained show: 1) a quali-quantitative spatial difference (fig. 1), of floristic spectrum regarding *Cystoseireta* of the Istrian Coast and of Trieste; 2) an alteration gradient in the floristic composition of *Cystoseiretum barbatae* (PIGNATTI, 1962) of Trieste as can be seen from: -2.1 disappearance of *Cystoseira crinita* (Desf.) Bory and *Cystoseira schiffneri* Hamel; -2.2 consipcuos presence of sciaphilous *Rhodophyceae;* -2.3) settling of nitrophilous facies in competition with the association *(Nitophyllum punctatum* (Stack.) Grev., *Gigartina acicularis* (Wulfen) Lamor., *Pterocladla capillacea* (Gmelin) Bornet in Bornet et Thuret, *Ulva letevirens* Areschoug in Phillips, *Colpomenia sinuosa* (Mert.) Derb. et Sol., *Corallina elongata* Ellis et Sol.).

In terms of time, always on biotic basis, a perceptible physiognomic seasonal difference of *Cystoseireta* of the Gulf of Trieste can be seen (fig. 2).

The disappearance of some species of the genus *Cystoseira* (2.1) and competition with species belonging to ord *Ulvetalia* (2.3) agree, on the other hand, with what GIACCONE (1977) said about the effects of environmental alteration on *Cystoseiretum barbatae* (PIGNATTI, 1962).

These observations reveal a situation of regression of the studied phytocoenosis as the effect of a different deqree of sedimentation and of the influence of urban sewage on benthic biocoenoses, that *Cystoseira barbata* (Good. et Wood.) Ag. seems to support (CINELLI, 1976). As a matter of fact it is known that pollution causes: on the one hand, clouding of the sea water and consequently the reduction of light penetration with the disappearance of photophilous species (2.2) (BRESSAN, WELKER & SERGI, 1991); on the other hand it enriches the environment with nutrients stimulating the appearance of nitrophilous species (GIACCONE, 1977) (2.3).

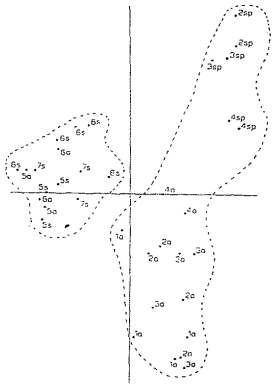

Fig. 1

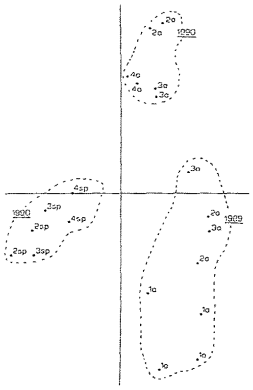

Fig. 2

Legend

1. Miramare
2. Aurisina 1 — TRIESTE
3. Aurisina 2
4. S. Bartolomeo

Sp = spring
S = summer
A = autumn

5. Val di Corrente
6. Faborsa — ISTRIAN COAST
7. Bagnole
8. Salvore

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Sedimentological and macrobiological characterization of an area south of Po River Delta, Adriatic Sea, Italy

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A sedimentological and macrobiological characterization of an area in the Northern Adriatic Sea is presented. The study area does not include nearshore environments. Sedimentary input is mainly due to the Po river; other rivers of Emilia-Romagna give minor contributions (BORTOLUZZI *et al.*, 1986).

The sedimentological and macrobenthic characteristics in the top 20-30 cm of sediments sampled by 8-replicas box-corers were examined. In particular we considered: grain size distribution; sedimentological structures; water content and redox conditions at different levels; type, degree and depth of influence of biological populations (CREMA *et al.*, 1991). Three main facies were identified (Fig. 1).

Facies A evidences an irregular, but continous belt from the submerged beach to the 12-18 m isobath. It is mainly composed of silts, generally oxidized at the surface; although, in places, some sand is present. In front of river mouths - proximal prodelta zones (facies A') - sediments are reduced, finer, and richer in flocculated materials. In general, erosion surfaces characterized by discontinuities and by layers or lenses of reworked shells frequently occur. The degree of colonisation is variable, usually very high. Macrobenthic faunas are not homogeneous: at shallower depths they mainly include *Owenia fusiformis*, numerous Amphipoda and Bivalves (especially *Corbula gibba)* with varying proportions; at relatively deeper depths Polychaetes (*Nephtys incisa, Sternaspis scutata* and *Lagis koreni*) and Mollusks (*Nucula nucleus*) prevail. These macrobenthic associations are typically found in sediments with high inputs of organic and inorganic detritus, that are subject to very strong reworking by waves and currents.

Facies B can be divided into three subfacies (B', B'', and B'''). In general, it includes all offshore deposition areas of river-borne fine materials, especially from the Po, and reaches 30-35 m depth. Grain size ranges from silt to clay. Macrobenthic populations feature muddy sea bottom species. The *Corbula gibba* bivalve and many species of Polychaetes - among which *Prionospio malmgreni, Aricidea claudiae* and *Aricidea assimilis* - prevail in surface layers, whereas polychaetes such as *Maldane sarsi* or *Glycera rouxii* dominate in deeper layers. Density of peuplement differ in the three subfacies.

Subfacies B' is located south of the Po delta and it spreads from facies A to 20-22 m depth. Sediments have grain sizes from fine silt to clay; at the surface they are highly hydrated and not always oxidised, whereas in depth they are always highly reduced and present very few discontinuity surfaces. In some cases lenses of decomposed Bivalves occur. In addition there is a low density of benthic fauna.

Subfacies B'' extends south of Ravenna and reaches 20-22 m depth. Sediments are mostly composed of silt, with clay and rare sand interbeds. Their colour indicates a general oxidised condition not only at the top. Discontinuities, shell debris deposits - even in lenses - and, in general, structures that indicate high energy on the bottom are frequent. The degree of macrobenthic colonization is medium-high to high. The peuplement is more varied in deeper layers, with the polychaete *Sthenolepis yhleni* associated to the above-mentioned species.

Subfacies B''' features offshore fine deposit areas. They are mainly composed of highly hydrated, dark green clays including some shell debris layers and fecal pellet lenses. The degree of macrobenthic colonisation is medium-high. This is an area where finer sediments, either resuspended at shallower depths or from large Po floods settle.

Facies C includes sea bottoms offshore 32-33 m. In this area relict sands of nearshore facies emerge. They were generated during sea level changes in the last Eustatic cycle. The ochreous or light grey colour, and the large colonisation mainly due to *Ophiura* indicate a strongly oxygenated environment which is undoubtedly affected by general Adriatic circulation currents.

It is important to emphasize that transition facies with heterogeneous benthic populations and lithological types are present between all the above-mentioned facies.

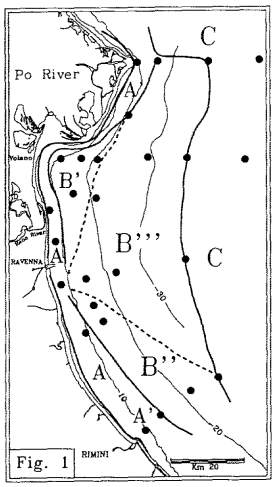

Fig. 1

In conclusion, we have been able to point out:

- a sharp definition among areas that do (A, B) and do not (C) receive modern river-borne material;

- a further distinction among facies that experience direct fluvial deposition (including also flocculated material) (A), and facies that are mainly influenced by eroded and redeposited, or lenghty transported fines (B);

- a third distinction within facies B sea bottoms that:
  - are protected by the Po delta from general current circulation and N and NE storms and receive high input from rivers (B');
  - are characterized by higher (B''') and lower (B'') impact of Po river fines;

- that benthic species are more sensitive to differences in lithology of substrata, rather than to differences in depth variations or chemical-physical conditions; on the contrary, population density is highly affected by the average oxigenation of sea bottoms.

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Quelques observations sur l'influence de la transparence de la mer sur la distribution verticale de *Nitophyllum punctatum* GREV. (Rhodophyta, Ceramiales)

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Dans des recherches sinécologiques précedentes BRESSAN *et al.* (1991) ont pu mettre en évidence quelques variations de la distribution verticale de macroalgues benthiques de l'étage infralittoral photophile (PhI) du Golfe de Trieste (Nord Adriatique) en relation significative avec des variations de transparence. Ces variations, observées en 1988 et 1989, étaient liées à des facteurs édaphiques et climatiques agissant sur la transparence de cet étage, tels que: la granulométrie, l'inclination, l'exposition à la lumiére; l'hydrodynamisme; la présence d'eaux polluées, etc. De cette façon on a pu remarquer qu'une réduction de la transparence porte à: une réduction de la distribution bathymétrique d'espèces, soit la limite maximale, soit l'intervalle de distribution (différence entre les limites - tab. 1); réduction de la diversité biotique; vicariance de quelques espèces sciaphiles sur quelques espèces photophiles.

Des exemples, qui sont tirés par le tab. 1, on pourrait affirmer que, du point de vue autoécologique, il exsistent dans cet étage des espèces qui, dans les stations examinées (1-Riserva Marina di Miramare; 2-San Rocco; 3-San Bartolomeo; 4-Cedas; 5-Aurisina LBM; 6-Duino) semblent être relativement:

1.- steno-...(variations bathymétriques réduites, comprises entre 10-60 cm.):

1.1.-...-photophiles (s.s.): *Acetabularia acetabulum* (L.) SILVA.; *Gelidium latifolium* (GREV.) BORN. & THUR.

1.2.-...- sciaphiles (s.s.): *Botryocladia botryoides* (WULFEN) FELDM; *Aglaothamnion tripinnatum* (GRATELOUP) FELDM.; *Peyssonnelia squamaria* (GMELIN) DECAISNE

2.-euri-...(variations bathymétriques plus marquées, comprises entre 10-190 cm.)

2.1.-...- photophiles: *Chylocladia verticillata* (LIGHTF.) GREV.; *Nitophyllum punctatum* (STACKH.) GREV.; *Cystoseira barbata* C. AGARDH; *Chondria dasyphylla* (WOOD.) C. AGARDH. *Gigartina acicularis* (ROTH) LAMOUR.;

2.2.-...- sciaphiles: *Cladophora pellucida* (HUDS.) KUTZ:; *Pterocladia pinnata* (GMELIN) BORN.

Tab. 1.- Distribution de profondeur (min/max.) espèces/stations (en cm.)

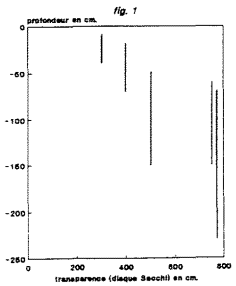
station n.	1	2	3	4	5	6		
transp. moyenne en cm.	770	750	500	440	300	300	G. espèce	gr.ecol.
	210÷230	100÷130					A. acetabulum	PhIC
		60÷120	50÷90				G. latifolium	PhI
SSP. PHOTOPHILES	40÷80	40÷200	30÷140		20÷60	-	C. barbata	PhIC
	40÷230	50÷120	40÷110	20÷120	30÷60		C. dasyphylla	PhIC
	30÷60	60÷110	50÷90		20÷40	20÷40	G. acicularis	PhIP
	10÷100	40÷100	50÷80	20÷70	0÷80	20÷40	C. verticillata	PhIC
	70÷230	60÷150	60÷150	20÷70	10÷30	30÷40	N. punctatum	PhIP
	50÷100	60÷150	50÷140	0÷120	30÷80		C. pellucida	SSB
	30÷100	60÷120	80÷110	20÷60		20÷40	P. pinnata	SSB
	80÷130		80÷110		60÷80		P. squamaria	SCIT
SSP. SCIAPHILES			80÷130		20÷40		B. botryoides	SSBc
				30÷70		30÷40	A. tripinnatum	SCI

Légende: "Gr. Ecol." (sensu BOUDOURESQUE, 1984): Ph=Photofile; I=Infralitoral; C= Mode calme; P=Portuaire; S=Sciaphile; SS= Sciaphile Superficiel; B= Battu; T= Tolérante; C= Affinité Chaude.

De cette façon, on a pu mettre en évidence que parmi toutes les espèces considerées l'adaptation qui semble régler la distribution bathymétrique, est en relation plus ou moins directe avec la transparence de la mer; en particulier, parmi les espèces euri-photophiles, on a pu observer en *N. punctatum*:

- une relation avec la distribution bathymétrique (fig. 1), qui résulte significative pour une seuil d'affinité du 27% à une probabilité du 95% pour des classes de transparence < 400 cm (cluster A) ou > 400 cm (cluster B);
- une corrélation directe avec l'interval de distribution bathymétrique ainsi que avec la profondeur maximale et minimale de *N. Punctatum* (fig. 2).

Les adaptations de distribution bathymétrique ci dessus décrites (tab. 1 et fig. 1-2) semblent être donc la manifestation écophysiologique des influences du milieu exercées par la turbidité de l'eau de mer sur cette espèce, probablement en raison de la relative simplicité structurale, morphogénétique, typologique du thalle de *N. punctatum*. En effet plusieurs études ultrastructurales ont pu mettre en évidence que cette espèce semble être particulièrement sensible aux variations de l'habitat tel que, par exemple: 1) un excès de gradiations rouges (645 - 661 nm) peut provoquer une division irrégulière des tylacoïdes (HONSELL *et al.*, 1978); 2) une diminination de la température de l'eau de mer peut influencer sur la présence de ficobilisomes sur les tylacoïdes (HONSELL *et al.*, 1985).



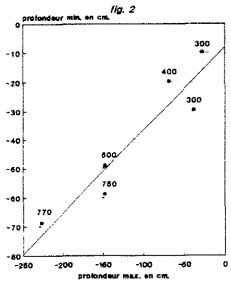


Fig. 1.- Interval de distribution bathymétrique en relation avec la transparence de l'eau (en cm).

Fig. 2.- Diagramme de dispersion de l'interval de distribution bathymétrique (profondeur minimale et maximale) en relation avec la transparence de l'eau (en cm).

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Benthic respiration in the Adriatic Sea and its effect on nutrient exchange at the sediment-water interface

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In order to estimate sediment efficiency in recycling nutrients within a marine basin, benthic fluxes and diagenetic reactions have to be assessed.

A joint Italian-Dutch investigation was carried out in western north central Adriatic in the period March 9 - 23, 1992, based on direct measurements and calculated estimates of oxygen consumption and nutrient regeneration rates at the sediment-water interface. This cruise was part of an EEC-STEP programme about the trophic problems of the Adriatic sea.

Earlier investigations (1,2) carried out in different hydrodynamic conditions, showed some evidence about the effect of sediment texture and accumulation rates of land derived fine materials on burial and recycling efficiencies of nutrients.

Accordingly, 8 stations were selected along the main sedimentary pathway of the Po river discharged load southwards, down to the continental slope (Fig. 1). The four stations in the NW area match some of the ones already studied, therefore some comparison in relation to different oceanographic regimes is allowed in order to infer more accurate estimates about nutrient budget on an annual scale.

At each station the following operations were carried out:

1) CTD profiling and sampling of the water column for on board analyses of dissolved oxygen and nutrients;

2) deployment of benthic chambers built in a free-falling vehicle (lander) for the estimate of sediment oxygen consumption and sediment-water exchange of nutrients;

3) deployment of an "in situ" oxygen profiling lander (TROL);

4) box-coring for squeezing of porewaters for the analyses of nutrients and total CO^2, and analyses of org. carbon and nitrogen, biogenic silica in the solid phase; oxygen penetration was measured in a subcore with a microelectrode device at the sea bottom temperature;

5) oxygen consuption rates from whole-core deck incubations;

6) qualitative and quantitative assessment of sediment fauna.

While the results for nutrient chemistry are still incomplete and of preliminary character, oxygen measurements gave interesting indications which can be summarized as follows.

Oxygen concentrations in the bottom waters were lowest at the northern stations (160 - 175 uM) and highest in the southern stations (260 - 280 uM). If compared to previous measurements, carried out in different hydrological regime (i.e. stratification) they are 10 % higher.

The penetration of oxygen into the sediment as measured with microelectrodes, both in-situ with the oxygen profiler (TROL) and in the lab are consistent. Smaller penetration depths (2 - 3 mm) were measured in Stat. 1 and 2, highest (15 mm) at Stat. 10, 250 m deep. Fig. 2 shows an example of "in situ" oxygen profile at Stat. 3. The presence of animal burrows, enhancing local increase of oxygen concentration is clear.

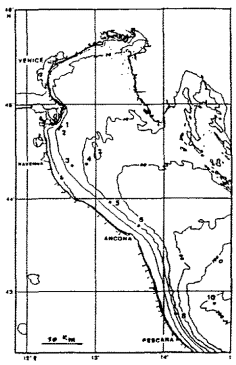

Fig. 1 - Map of the stations

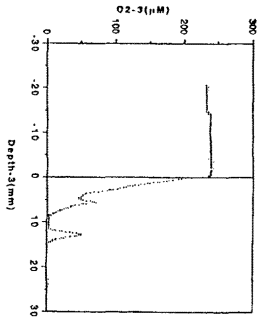

Fig. 2 - In-situ oxygen micro-electrode profile, made with TROL at stat.3. The presence of animal burrows is seen at 6 and 12 mm depths.

Oxygen consumption rates at different stations measured both by deck incubations of whole cores and by "in situ" benthic chambers and those calculated by diffusion modelling from the TROL profiles show relative good correlations. Compared to the "in situ" incubation technique (benthic chamber deployment) diffusive fluxes result somewhat lower, indicating the effect of bioturbation on the experimental fluxes. Data from this field trip are comparable to previous results, pointing out that different oceanographic conditions do not seem to affect benthic respiration in the studied area.

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X

Similarity of littoral biocoenoses in the National Park "Kornati"

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The results of a long-term (1979-1981) study on macrozoobenthos structure in the littoral biocoenoses of the Kornati Archipelago are presented. Qualitative similarity of different study localities was expressed with the similarity index (QS) using modified SORENSEN statistical method (GAMULIN-BRIDA, 1960). The method is based on the common animal species, where

$$QS = \frac{2c}{a+b} \times 100,$$ a the number of species at A locality, b at B locality,

c the number of species common to compared localities A and B.

The study was performed at eight (P1-P8) ecologically different localities (Fig. 1) and concerned macrozoobenthic forms only at different bionomic levels (supralittoral, mediolittoral, infralittoral and a part of circalittoral down to 100 m depth). The zoological material was collected by direct observations and material collection from a square surface of 1/16 square metres down to 50 m by SCUBA divers and by the indirect method using grab, dredge and trawls at depths from 50 to 100 m.

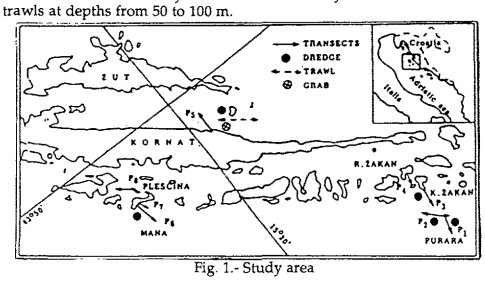

Fig. 1.- Study area

Bottom type and habitat slope, as well as the level of exposure to the waves and marine currents and local illumination are basic factors affecting the distribution of benthic organisms.

Southerly exposed coasts of the outer series of Kornati Islands (Islands Purara P1 and Mana P6) are characterized by vertical cliffs descending down to 50 m under the sea, with a plain with soft bottom formed below it. Soft bottoms occur as small sandy surfaces at 1 m depth already on other slope and rocky coasts of mentioned islands as well as on the coasts of more protected islands. Southern coasts of outer islands are also exposed to stronger illumination and stronger wave effects. All these factors caused benthic fauna to differ in structure and composition between studied localities, which is expressed by the similarity index in this paper (QS) (Fig. 2).

	P1	P6	P3	P5	P2	P8	P4	P7
P1		■	/	/	/	/	●	●
P6	81		/	/	/	/	●	●
P3	65	69		/	/	/	/	/
P5	62	59	74		/	/	/	/
P2	60	59	72	70		■	/	/
P8	60	59	68	66	82		/	/
P4	48	46	64	63	70	62		/
P7	46	39	54	58	54	50	56	

■ 75 - 100 %
/ 50 - 74 %
● 25 - 49 %
○ 0 - 24 %

Fig. 2. A comparison of similarity indexes (QS) between the studied localities on the basis of common animal species

The obtained values show greatest similarity in animal structure (QS = 82) between benthic populations from the western coast of Purara Island (P2) and western coast of Plescina Island (P8), as well as between the benthic populations on the southern shores of Purara (P1) and Mana (P6) islands owing to their great similarity in biotopes and spatial orientation.

The lowest similarity was recorded between the benthic populations on the southern vertical coast of outer islands Purara (P1) and Mana (P6) and those on the slope and shallow shores of Mana (P7) and Ravni Zakan (P4) islands, which differ ecologically, as well (QS P6 - P7 = 39, QS P1 - P7 = 46, QS P6-P4 = 46, QS P1 - P4 = 49).

Relatively low similarity in animal structure of benthic populations (QS = 56) was recorded from the Islands Ravni Zakan (P4) and Mana (P7). No greater similarity was due to the fact that both biotopes occur on slight slopes and in shallow water, spatially differently situated. The former is situated in the sheltered and the latter in the unsheltered part of Kornati Islands.

Similarity of animal structure between the rest of study localities expressed as the similarity index (QS) of 50 to 70 points to the fact that they are intermediate between vertical, exposed and deep localities and slightly sloping, protected and shallow localities.

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An account on bivalves populations in the Northern Adriatic Sea

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In the northern Adriatic Sea bivalve species important in bottom communities, are occasionally under stressed environmental conditions (DEGOBBIS *et al.*, 1991), sometimes associated with mass mortalities such as those registered in 1974, 1983, 1988, and 1989 (JAKLIN & ZAHTILA, 1990; STACHOWITSCH, 1991).

From 1978 to 1991 bivalves were collected by dredges, grabs, and Scuba divers. In total 65 bivalve species were identified which number varied between 1 and 24 per station and per sample. The species numbers increased towards the west coast of the Istrian peninsula, and at stations located along the western coast of Istria, in comparison to stations located along the Italian coast (Fig. 1). Occasionaly, the highest species numbers, at stations 101 and 107, indicated probably an optimum species numbers in the bottom community, like in 1985 (Aug.), 1986 (Dec.), 1989 (Aug.), and 1990 (Nov.) (Fig. 2). The bivalve species composition was almost the same in these findings.

The species decrease especially in spring at stations 101 in May, June and July (1978, 1983, 1987, and 1988) could be attributed to the increased Po River discharge causing changes of some marine environmental factors. Late summer and early autumn species decreases were related to anoxic or/and hypoxic conditions in the bottom layers, after phytoplankton "blooms". The evidences sre clear at station 107 in 1979 (Dec.), 1984 (Dec.), 1988 (Oct.), and at 101 and 107 in 1989 (Dec.) (Fig. 2). The result of decreased oxygen content near the bottom, in autumn 1977, was observed in a sample from March 1978 with a few specimens of *Corbula gibba* and *Myrtea spinifera*. Several species with a wide ecological distribution such as *Corbula gibba, Myrtea spinifera, Nucula nitida, Pitar rude,* and some others like *Cultrensis adriaticus, Thyasira flexuosa,* and *Mysia undata* survived the critical periods depending on the degree of dissolved oxygen concentration in a particular sampling area. The recovery of bivalve populations begins in spring when most of the bivalve species start to reproduce. Such recovery is conspicous at station 107 from December 1989 (4 species) to November 1990 (20) with a decrease in April 1990 (13) (Fig. 2).

In conclusion, the recovery of bivalve populations was quite successful and rapid with almost all species noted previously in this area in the "normal" years. But the question is for how long, and how many such disastres will have to suffer some sensitive species before they completly disapper from the northern Adriatic Sea

Figure 1. The highest species numbers at various research stations from 1978 to 1990.

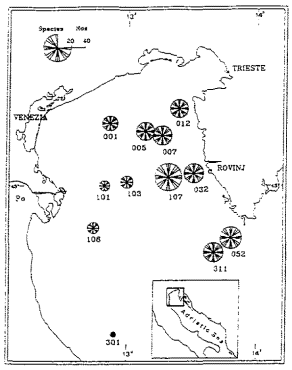
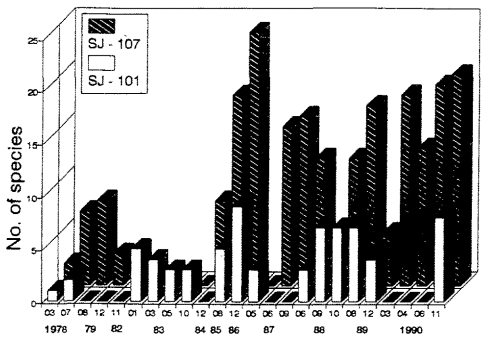


Figure 2. Bivalve species numbers at two stations surveyed.



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X

Recovery of benthos after anoxic stress. II. Bivalve Mollucs

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After a mass mortality of benthic organisms in the autumn of 1989 (JAKLIN & ZAHTILA, 1990) the recovery of bivalve populations was studied at stations 005, 007 and 107 (Fig. 1). Samplings from a 0.4 m^2 bottom surface were done by a Van Veen 0.1 m^2 grab at almost one month intervals, from December 1989 to September (005 and 007), and November (107) 1990.

Samples collected at station 005 in December 1989 contained *Corbula gibba, Chione ovata, Myrtea spinifera, Mysia undata* and *Thracia papracea;* at station 007 *Corbula gibba, Mysia undata* and *Nucula nucleus;* and at station 107 *Corbula gibba, Nucula nitida, Thyasira flexuosa* and *Tellina* sp. Only adult specimens were noted.

After the autumn of 1989 anoxia the repopulation process started in the spring of 1990 either by juveniles of survived species, by species inhabiting in neighboring zones, or by species distributed southwards which larvae were drifted towards the northern Adriatic by the main currents. First juveniles of several species appeared in February, especially at station 107. From December 1989 the bivalve species numbers increased from 5 to 16 species at station 005, from 3 to 17 at station 007, and from 4 to 20 at station 107. An insignificant species decrease was noted in April 1990 (Fig. 2).

Some bivalve species showed a high recruitment rate until June. The most abundant species was *Corbula gibba* (390 specimens per sample), the next ones were *Chione ovata* (219) and *Musculus marmoratus* (77). Less abundant were *Acanthocardia echinata* (43) in March, *Mantellum hians* (42) in June, *Nucula nitida* (37) in September, *Laevicardium oblongum* (41) in November, and others (Fig. 3). In 1990 the recovery of *Pinna pectinata* populations was recorded from specimens 38 mm (Apr.) to 160 mm in length (Sept.) according to diver sampling collections.

At station 107 in December an adult *Corbula gibba* population consisted of specimens 10.0-12.2 mm in length. The settlement of juveniles about 2 mm in length started in February and continued until June, when the smallest specimen was about 4 mm in length. It seems that a natural mortality of adults had begun in February but until June the *Corbula* population structure, in general, did not altered (Fig. 4).

The recovery of bivalve species in the area affected by anoxia in the autumn of 1989 was successful and rapid, as their reproduction season began already in the spring of 1990.

Figure 1. Research stations in the area stressed by 1989 anoxia.

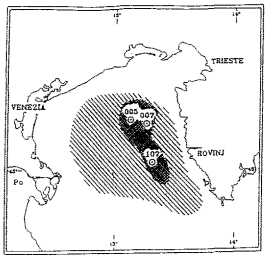


Figure 2. Bivalve species numbers in the early recovered period.

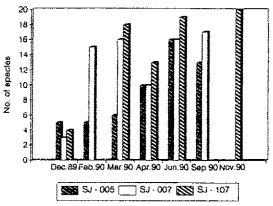


Figure 3. Population recovery of some common bivalves.

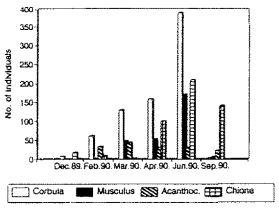
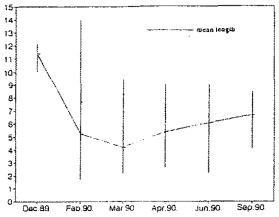


Figure 4. Population structure of *Corbula gibba*.



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Ulva Rigida (Chlorophyta) in the North-Eastern Adriatic fouling communities with regard to different environments and substrata

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In the northern Adriatic seaweeds are not an important element in fouling communities. The most frequently noted species is *Ulva rigida* C. Agardh, 1822. It is a typical species for the fouling on floating objects throughout the world. Being a nitrophile species it inhabits before all slightly polluted environments (PERES, 1967) but also rather polluted harbors, where it is accompanied by some other algae (*Enteromorpha, Cladophora, Chaetomorpha*) representing the main nitrophile facies (RIGGIO, 1979). Therefore *Ulva* is considered the main eutrophication indicator in the sea and estuarine environments influenced by urban sewage effluents (HO, 1981). *Ulva* is as well common in cleaner environments richer in riverborne nutrients.

The data were collected from supralittoral to upper infralittoral, over a period of 20 years. All data are expressed as average values and are presented in a form consistent with standard ecological methods, so that frequency is according to ODUM (1971) and cover is after PERES & PICARD (1964).

Along the north-eastern Adriatic coast Ulva is the most frequent and the most abundant in slightly polluted harbors and in shellfish parks rich in nutrients, while in clean localities and shellfish parks poor in nutrients *Ulva* is of secondary importance in fouling communities (Table I). But in the Rijeka petrol-harbor, rich in nutrients. the settlement of *Ulva* was not intensive, probably due to a considerable oil pollution.

With regard to the substratum *Ulva* reacts differently. Its distribution over different parts of a ship is in correlation with light intensity, coating toxicity, relative water speed during sailing and similar. Because of this *Ulva* never settles on the keel of ships, axis of propellers, and on very toxic coating layers. However, the texture of the substratum could be of influence to the settlement of the *Ulva* species. For example, the rough surface of an oyster shell is more favorable for settling than the smooth shell of a mussel or glass plates (Table I).

The ecological importance of *Ulva* as a fouling species is unsubstantial, except on floating objects, because of its low abundance, growth, biomass, and low covering rate. Being a fouler *Ulva* very rarely reaches the adult stage, its thalli were in average only 3-8 mm high, extremely 71 mm on oyster shells. Only on the hulls of ships domiciled in harbors slightly polluted by urban sewage, in the upper part of the water line, *Ulva* thalli reached the length up to 20 cm but towards the ship-keel their dimensions decreased successively to only about 1-2 cm.

The seasonal distribution of *Ulva* is not strictly determined. At most it was found in the fouling from May to October with a peak in June.

The dynamics of *Ulva* in fouling communities is very accelerated alreadv after 15 days of exposure of the test substratum the thalli start to die out, and the mortality begins after 1-2 months, rarely after 4 months. The reason of such an accelerated development of *Ulva*, which thalli almost never reach the adult stage, is the fouling competition and kind of substratum.

Table I. Frequency of occurrence (F %) and average cover (C %) in relation to various substrata and environments (*rich in nutrients).

	Non-pollut. sites		Shell-fish parks		Petrol harbor		City harbor	
	F	C	F	C	F	C	F	C
Glass plates	4	8			*6	5		
Ostrea edulis			*50	12				
			1	5				
Mytilus gallo-provincialis			*4	7				
			2	7				
Fishing ships:								
Bow							25	7
Hull							25	3
Stern post							13	40
Stern							25	6
Rudder							25	60
Propeller - sides wing: external							50	66
internal							25	60

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X

Structural change in a North Adriatic sediment macrofauna

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An increasing input of nutrients into the North Adriatic was noted during the last decades (MARCHETTI *et al.*, 1989). The rise of the primary production evident like phytoplankton blooms in the course of the last 5-6 years made large quantity of organic matter available for the consumers. A certain part of this matter is consumed through bacterial activity requiring considerable amount of oxygen. In conditions of clearly vertical stratification of the sea water column, the concentration of dissolved oxygen is decreasing at the bottom layer. This is one of the factors which lead to hypoxic and anoxic conditions in some parts of the shallow North Adriatic. Such unfavorable conditions for benthic assemblages have already been noted previously, but recently they appear almost as a rule, after the summer period every year.

Macrobenthos was sampled at three offshore stations, in the period 1982-83, November 1990 and October 1991 (Fig. 1). A 0.1 m^2 Van Veen grab and sieve of 2mm mesh were used at all stations surveyed, species diversity recently has noticeable decreased and fell down to the half of the starting value, but the specimen number remained at approximately the same level or increased a bit (Table I).

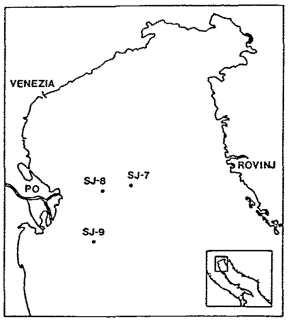

Figure 1. Research stations.

In the community composition indicative changes took place. In the samples from 1982-83, according to abundances, dominated the groups of Polychaeta, Echinodermata and Sipuncula (ZAVODNIK and VIDAKOVIC, 1987). Recent data, however, show an absolute dominance of Mollusca group which account for 80% of all individuals. The share of Polychaeta and Echinodermata remarkably fell down. At the station SJ-7, where echinoderms dominated in the samples from 1982-83, in October 1991 no specimen alive was found. In the contrary, Sipuncula account for 73% of total number of macrofauna collected in the sample (Table II).

Table I. Macrofauna diversity (S) and abundance (N m^{-2}) at station surveyed.

Year		'82	'90	'91
Samples /stat.		30	4	4
7	S	91	41	22
	N	1013	2120	767
8	S	89	30	39
	N	1165	1596	1570
9	S	62	32	32
	N	848	1292	1337

All three stations are located in the area of Vatova's zoocoenosis *Turritella* (VATOVA, 1949). The abundance of the screw-shell *Turritella communis*, the preferent species of coastal terrigenous ooze, decreased in regard to the initial situation at the station SJ-7. In the meantime the number of alive individuals have risen at the stations SJ-8 and SJ-9.

The multiplying share of mollusks in total abundance primarily account for bivalve shell *Corbula gibba* the species of wide ecological distribution which is considered to be an indicator of pollution and/or instability of the community (FAO/UNEP, 1986).

Table II. Relative abundance of different groups.

Station	7			8			9		
Year	82	90	91	82	90	91	82	90	91
MOLLUSCA	15	82	81	10	86	81	6	64	19
SIPUNCULIDA	13	3	1	5	5	4	6	21	73
POLYCHAETA	54	11	14	36	5	8	21	19	6
ECHINODERMATA	16	1	1	48	2	4	66	2	0
VARIA	2	3	3	1	2	3	1	3	2

The species of *Amphiura filiformis*, *A. chiajei* and *Notomastus latericeus*, dominating during the period 1982-83, have almost completely disappeared in samples. At the station SJ-7, the number of sipunculid *Aspidosiphon kovalewskii* has enormously grown up. According to ZAVODNIK and VIDAKOVIC (1987), this growth could be refered to decreasing number of alive individuals of *Turritella communis*.

Table III. Minimum oxygen saturation in the bootom layer.

Year	82-83	91
7	49	17
8	31	10
9	24	29

At stations surveyed, the oxygen saturation data in the bottom layer in 1991 imply the changes in the lowest oxygen values (Table III).

The minimum concentrations in October are three times lower than noted within the period 1982-83 at stations SJ-7 and SJ-8, while its value at the station SJ-9 remained at about the same level. In any case, these values are below the "biological anoxy" limit (STACHOWITSCH, 1991).

We consider the described changes in benthic community structure as a direct consequence of repeated seasonal concentration falls of dissolved oxygen at the bottom layer during the autumn. According to our data the macrofauna at the station SJ-7, which was chosen as a control station during the research in 1982-83, is the most affected. The pronounced domination of *Corbula gibba* and a diminishing species number at the same time, suggest an important change in benthic macrofaunal assemblages. Although in past years no new mass mortality of organisms has been noted, the communities obviously are under constant pressure of limiting environmental factors which do not allow the re-establishment of stable conditions.

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X

A benthic foraminiferal record documenting the onset of eutrophication in the Northern Adriatic Sea

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The vertical distribution of benthic foraminifera in a core in front of the Po delta (Fig. 1) has been studied in detail. According to our age model, based on ^{210}Pb and ^{137}Cs analyses of a core on the same location, this core documents the last 160 years. The isotope profiles further show that sediment mixing is largely limited to the top cm of the sediment, suggesting that this core should provide an extremely detailed record.

Benthic foraminiferal patterns and grainsize analysis indicate a number of substantial changes in sedimentation rate, food and oxygen availability in the benthic ecosystem. Changes occurring at about 1840 and 1880 can be attributed to man-induced changes in the main outflow canals of the Po river. The first led to an important reduction of the marine vegetation cover which had been present up to that date. The second one resulted in the present-day situation in which the Po outflow is passing the studied core locality closely.

From 1900 onwards, the benthic foraminifera indicate a steadily increasing nutrient load. This trend is interpreted as the effect of the anthropogeneous eutrophication, due to agriculture and waste water disposal. A marked faunal transition around 1930 indicates the intensification of eutrophication.

Around 1960 the first signs of an increasing importance of anoxic events can be recognized in the benthic record. The faunal changes in the last decade, which were described to changes in preservation potential, indicate that more intense or more prolonged anoxia started about 10 years ago, and that the ecological health of the northern Adriatic is still in decline.

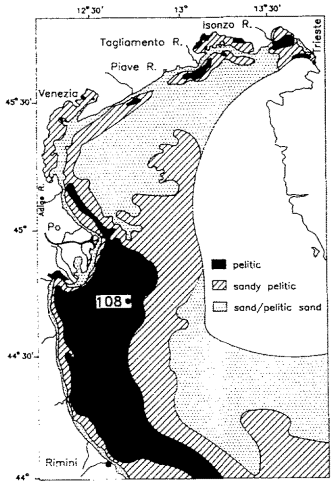

Fig. 1.- Location of core station 108 (water depth 32 m), plotted on a simplified surface sediment map (after BRAMBATI, CIABATTI, FANZUTTI, MARABINI and MAROCCO (1983): A new sedimentological textural map of the northern and central Adriatic Sea. *Boll. Oceanol. Teor. Applic.*, 4, 267-271).

Data on the Albanian Marine Flora

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The Albanian seacoast as an ecological environment displays two aspects: the Adriatic-accumulative zone with shallow waters, wherein many rivers pour their waters, and Ionian-abrasive zone very rugged, with deep and clear waters, and where there are norivers.

Studies on the marine flora of this part of the Mediterranean are wanting. Only ERCEGOVIC (1952, 1960) and MARKGRAF (1928) mention 15 species. The first attempts are made by me (KASHTA 1981, 1986, 1988). The studying and collection of the material is performed at various stations along the entire coast using aqualungs (down to 30-40 m deep). We have also used the materials collected from fishing ships, their bottom nets down the isobats 50-60 m deep.

We could identify 131 macrophyt algae species till now. The ratio R/P is 2.5. We identified also 4 marine phanerogam species. In general, the benthic population of the Albanian coast has a typical Mediterranean physionomy which is characterized by the abundance of the Mediterraneo-Atlantic species. The Atlantico-Mediterranean element covers 54% of our species, the Mediterranean endemic 22%, and the cosmopolit 10%, etc.

The Albanian seacoast is situated on the limits of three special bio-geographic units: Eastern Mediterranean, Western Mediterranean and the Adriatic; and it has a favourite position in view of floral and bio-geographic interest. This is observed in the presence of some species which find here their areal limits.

-*Fucus virsoides* J.Agardh already known species as an Adriatic endemic mainly concentrated in the Upper Adriatic. In Albania, you come acrose it in the North and South of Durrës, and in rare individs in Treport (Vlora). This last finding presents the Southern limit of its areal which corresponds to the geographic border of Adriatic.

-*Lithophyllum lichenoides* (Ellis) Lemoine- a characteristic species of Western Mediterranean, not found in the Eastern Mediterranean, except for the coast of Western Creete and the fossil formations of Holocen(LABOREL, 1981). According to HUVE (1963), this species is exclusively located in the Western region and not along the East Adriatic and the Dalmatian coasts. Our findings in Himara zone (Ionian Sea) are at further Eastern stations, compared with the Dalmatian ones, and they extend the areal of this species in Mediterranean, a little bit to East.

-*Halophila stipulacea* (Forsk.) Aschers, a sea phanerogam with subtropical and tropical affinity, is mainly concentrated in the Eastern Mediterranean. The Isle of Malta is its most Western limit in the Mediterranean (AUGIER, 1982). Our coastal findings in Saranda (Ionian) and in the Bay of Vloru, (Adriatic) constitute the Northern limit of its extension.

It is interesting to be noted that both *Halophila stipulacea* and *Polyphysa parvula* (Solms-Laubach) Schnetter and Bula -Meyer, thermophile species of Indian Ocean origin, have found snelter in the Bay of Vlora. They both represent new species of the Adriatic Sea.

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Fourier shape analysis of *Elphidium crispum* (LINNAEUS) from the Gulf of Piran (Northern Adriatic) : preliminary results

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There is an abundance of information on the relationships between environmental parameters and intraspecific morphologic variability in benthic foraminifera. Modern quantitative image analysis allows rapid, accurate and objective analysis of numerous specimens and makes possible to examine subtle changes in foraminiferal test morphology along the environmental gradient. In the past two decades Fourier morphometric techniques have been successfully applied to numerous studies of various organisms, especially foraminifera (e.g. GARY & HEALY-WILLIAMS, 1988).

In the present study we used five samples from the Gulf of Piran (Fig.1) from the collection of the Institute for Paleontology ZRC SAZU, Ljubljana. Samples were taken from sites, ranging from the Mouth of Dragonja river to the open Adriatic. They were chosen according to sedimentological and chemical data of RANKE (1976), so that they exhibit maximal differences in environmental conditions. From each sample we selected 24 specimens of *Elphidium crispum* with 22 to 28 chambers in the last whorl. Specimens were correctly mounted on glass slides, and the outline of the side view of each specimen was quantified using a computerized image analysis system of the Institute of Biophysics, University of Ljubljana. The system consist of a video camera mounted onto a microscope, a video recorder and a digitizer, all interfaced with a computer. The analog signal from the camera is digitized, and the edge-finding algorithm of the computer locates the foraminiferal test boundary. The shape analysis program transforms the digitized outline to Fourier series.

Fourier analysis develops a mathematical expression for the radius of the shape outline measured from an origin in the terms of the polar angle. The radius is given by :

$$r(\theta) = a_0 + \sum_{n=1}^{N}[(a_n \sin(n\theta) + b_n \cos(n\theta)] \quad \text{or} \quad r(\theta) = c_0 + \sum_{n=1}^{N} c_n \cos(n\theta - \phi n)$$

noting that

$$c_n^2 = a_n^2 + b_n^2 \quad \text{and} \quad \phi_n = \arctan(b_n/a_n)$$

where a_n and b_n are Fourier coefficients, c_n is the harmonic amplitude, and $\varnothing_n$ is the phase angle. The subscript n is the harmonic number or simply the harmonic.

Each harmonic amplitude represents the relative contribution of the specific shape component to the total test shape. The "zeroth" term (a_0 or c_0) represents the mean radius of the outline. The first harmonic amplitude describes a centering error. The second harmonic amplitude measures the contribution of a figure eight, and the third harmonic amplitude measures the contribution of a trefoil to the total shape. In general, the "nth" harmonic amplitude represents the shape contribution of a "n-leaved clover". The associated phase angle orients each shape component relative to the other shape components. Each harmonic amplitude can be used as amorphologic variable, and the test shape can be described as precisely as desired, depending on the number of harmonics calculated.

In the present study only the first ten pairs of Fourier coefficients were computed from 64 peripheral points spaced at equal angles subtended from the center of gravity of the outline. Visually, these 10 terms sufficiently reproduce relative smooth outlines of E. *crispum*.

The set of harmonic amplitudes constitutes the harmonic amplitude spectrum. Each sample thus consist of 24 spectra of nine harmonic amplitudes (the first harmonic amplitude is an error measurement and was not used for further analysis). Amplitude values are normalized (divided by the a_0), so that the differences in size do not affect shape comparisons. By the relative entropy method (FULL*et al.*, 1984)(Fig.2) we determined that harmonic amplitudes 3 and 4 contain the most information concerning intersample shape variability of E. *crispum* from the Gulf of Piran.

Figure 3 shows a comparison of sample amplitude means for harmonics 3 and 4 of *E. crispum* and environmental parameters (median grain size, total carbonate content, organic carbon and Eh values) in the surface sediments of the Gulf of Piran. The grain size and the carbonate content increase from the Mouth of Dragonja towards the Gulf entrance. The content of C_{org} in the surficial sediments has an inverse gradient. Eh values are positive for all surface sediments, however the depth of the Eh(0)-layer, ranging between 1 and 10 cm, increase seawards (RANKE, 1976). Mean harmonic amplitudes 3 (triangularity) and 4 (lobateness) both decrease from the Dragonja mouth (sample SEC) toward the open Adriatic (sample PI42).

We can see (Fig. 3) that there is a correlation (positive or negative) between test morphology of *E. crispum* and environmental properties taken into account. However, we cannot define any causal relationships from these preliminary data. Furthermore, we think that morphologic variability of *E. crispum* from the Gulf of Piran is not so much the result of environmental gradients mentioned, but more the response to the temporal (seasonal) changes in ecological parameters, which affect the growth of E. *crispum* and make its peripheral margin uneven.

Acknowledgements

I thank F. SUSTERSIC for introducing me to Fourier techniques, F. CIMERMAN for providing the sample material, collected by K. DROBNE and F. VELKOVRH, F. SEVSEKand J. MAJHENC for use and assistance with their image analysis system and D. PAZIN for computer assistance.

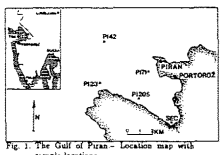

Fig. 1. The Gulf of Piran - Location map with sample locations.

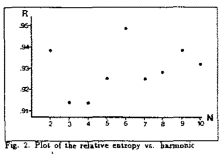

Fig. 2. Plot of the relative entropy vs. harmonic number.

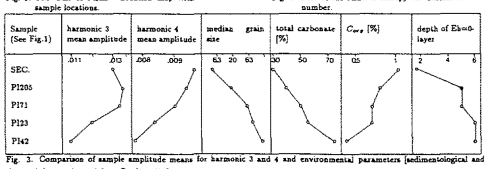

Fig. 3. Comparison of sample amplitude means for harmonic 3 and 4 and environmental parameters [sedimentological and chemical data estimated from Ranke, 1976]

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X

Growth strategies of *Fucus virsoides* (Don.) J. Ag. in different media

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The Adriatic seaweed *Fucus virsoides* (Don.) J. Ag. is able to penetrate into low-salinity areas and is rather tolerant to environmental stresses. It was cultivated in diluted seawater as well as in two different types of natural mineral waters in order to find out whether this eulittorial fucoid is able to survive in media other than seawater.

Salinity influence on the chemical composition and physiological properties of fucoids was reported (MUNDA and KREMER 1977) and the Adriatic *Fucus virsoides* was studied separately regarding its autecology and responces to different ecological stresses, such as dilution, excess of nutrients and heavy metals (KREMER and MUNDA 1982). In this preliminary contribution the influence of two different natural mineral waters on the survival and growth of *Fucus virsoides* is dealt with. One of the waters used in the present experiments originates from a typical acrothermal spring (Dobrna - spring temperature 35.6°C), which contains 74 $mg.l^{-1}$ of Ca, 21 $mg.l^{-1}$ of Mg, 1 $mg.l^{-1}$ of Cl, 318 $mg.l^{-1}$ of HCO_3 and traces of V, Li, Fe, Al, Cu, Zn. The other mineral water (Radenska spring) is rich in free CO_2 as well as in Ca (219 $mg.l^{-1}$), Mg (96 $mg.l^{-1}$), Na (480 $mg.l^{-1}$), with 47 $mg.l^{-1}$ of Cl, 89 $mg.l^{-1}$ of SO_4 and 2370 $mg.l^{-1}$ of HCO_3.

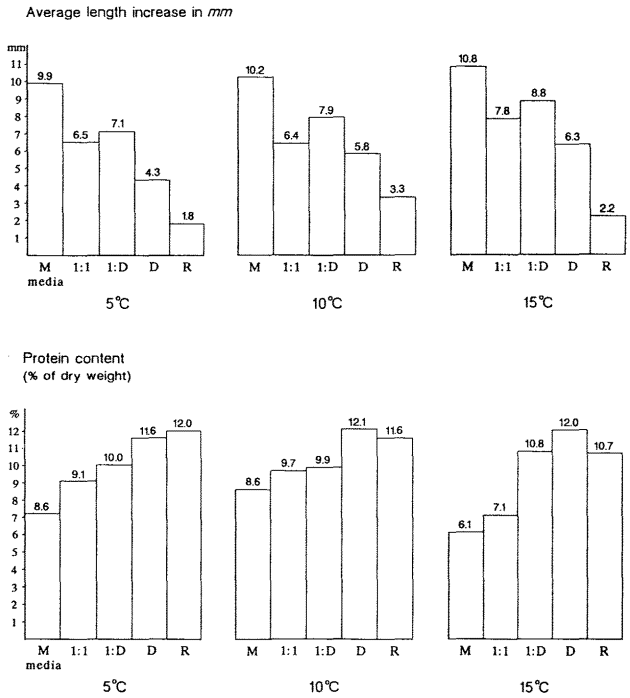
Methods

Adults plants of *Fucus virsoides* were collected at Piran in the Gulf of Trieste during different seasons. Ten subsequent series of experiments were run with winter, spring, late spring, summer and autumn material of this species. Small individuals from the same population or pieces of bigger plants (3 - 5 cm long) were kept in stagnant media in 500 ml glass dishes at 5°C, 10°C, 15°C, and in some series also at 20°C. The following media were used : filtered seawater - salinity 37.87‰ (M) diluted seawater - salinity 17,61‰ with a - freshwater (1 : 1), b - with water from the Dobrna spring (1 : D), water from the Dobrna (D) and the Radenska (R) springs. Media were changed every third day. The length increase (in mm) of the experimental plants was measured after two, four, eight and twelve weeks incubation. At the end of the experiments the protein content was determinated by micro Kjeldahl procedure.

Results

Results of all the experimental series indicated that *Fucus virsoides* is able to survive and even grow slightly in media other than seawater viz. natural mineral waters. Values (elongation in mm and protein content) for one of the series run with spring material are presented in the figure. The overall trend of media-dependent growth performance showed the usual dilution (induced, decrease in the 1 : 1 medium whereas dilution of seawater with the Dobrna spring water (1 : D) enhanced growth. In some of the series it even surpassed that of the control plants. In the two mineral waters growth was decreased to about one half in the Dobrna water and even more in the Radenska water, as related to the controls. Growth maxima were indicated at 15°C for plants kept in the diluted media and the Dobrna water, whereas in the Radenska water growth was decreased at the higher temperatures. In the latter necrosis was noticed after four weeks and in some cases even earlier, while the Dobrna water allowed survival and growth even after a twelwe weeks incubation. Plants collected during different seasons did not deviate from this trend, thought some variations regarding the growth expresions and temperature optima were notable (10°C for the winter and the early spring material and 15°C or 20°C for the rest). The relation beetwen growth performances in the two extreme stress media varied with the seasons in wich the plants were collected. Growth was lowest in the summer material where necrosis ocurred soon in the two stress media. The protein content, measured at the end of the experiments exhibited the usual trend of dilution induced increase. In all the experimental series it was highest in plants kept in the two mineral waters, reaching up to 16% of dry weight in the summer material.

Media-induced growth strategies varied, however, with the time when the plants were collected. Growth was highest in the material collected in late spring. In this case growth of plants kept in the 1 : D medium surpassed that of the controls, while pure Dobrna water induced a relatively hight growth performance.



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X

Evolutions of the Phytocoenoses circalitoral of the Northern Adriatic Sea : The Maërl

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This study is a part of a wider research to investigate the transformations in time and space of the phytocoenoses typical of the Northern Adriatic Sea (and particularly in the Gulf of Trieste).

Attention has been concentrated on the circalitoral zone and specifically on the facies with sea bed currents.

The vegetal sampled forms are: *Lithophyllum racemus* (LAMARCK) FOSLIE, in the biocoenosis of the coarse sands and fine gravels under bottom currents (SGCF); *Lithothamnion corallioides* CROUAN et CROUAN and *Phymatolithon calcareum* (PALLAS) ADEY et MC KIBBIN characteristic species of the maërl, facies of the biocoenosis of the coastal detritic (DC); and *Spongites (Lithothamnium) fruticulosa* KUTZING and *Lithothamnion valens* FOSLIE, facies of DC (PERES, 1967).

These species are very useful as indicators of environmental changes: both from the spatial point of view, as rolling algae because of their dependence on the currents and as calcareous structure because of their dependence on the water variation of pH, salinity and temperature; and from the temporal point of view, because they are perennial species, reflecting the variations of many years.

The mapping of maërl distribution has involved a wide area from Grado to Venice (NICHETTO, 1990) including 15 sampling sites in Italian waters and one reference taken at Rovinj (Croatia).

Five samples have been taken from each sampling site; the algae have been defined, weighed (dry weight), submitted to physiological checking (photosynthetic analyses, to discover the relationship between pigments and functionality) and as well as being submitted to isotopic analysis (in order to show up possible differences among the sampling areas); the data were combined into matrix and thereafter elaborated by multivariated analysis (BRESSAN & NICHETTO, 1992).

A gradual increase in biomass from the samples taken from the area of Grado to that of Venice (fig 1 & 2) has been noted.

This observation has been confirmed by the results of the eco-physiological experiences (analysis of photosynthetic capability of thalli with different pigmentation (NICHETTO & GHIRARDHELLI, in presentation), that show that the majority of living samples are found near Venice, and propose again, in functional terms, the gradient of average abundance (fig. 2).

The results are also confirmed by isotopical analyses conducted on calcium carbonate of ground samples of thalli, that show up quite big differences between the sampling areas of Grado, Caorle and Venice (NICHETTO, 1990).

From a temporal point of view we noted a contraction in the areals since the previous situation as described by the "Carta di pesca del Golfo di Trieste (CNR, 1968) and by BRESSAN (1968, personal communication) and OREL, VIO & ZANITTI (1981-82).

In synthesis two gradients of abundance and luxuriance of calcareous species can be seen: the first parallel to the coast line (from the Grado to the Venice one) and the second (in Venice area) perpendicular to the coast, towards the centre of the Adriatic Sea (fig. 3). This first description of the event could be interpreted by environmental means with a better knowledge of: a) variation of sedimentary rhythm (continental waters) of the Northern Adriatic Sea and consequent adaptation of the maërl species in the investigated areas; b) granulometric gradient (inshore/offshore); c) hydrical trophism and therefore eutrophy/oligotrophy gradient (inshore/offshore and surface/bottom).

These first results are also confirmed by observing one particularly rich reference sampling site (S. Giovanni in Pelago - Rovinj - Croatia). The data from this site are very different from those previously referred to.

Therefore the Rovinj site seems to be closer to the climax of maërl facies.

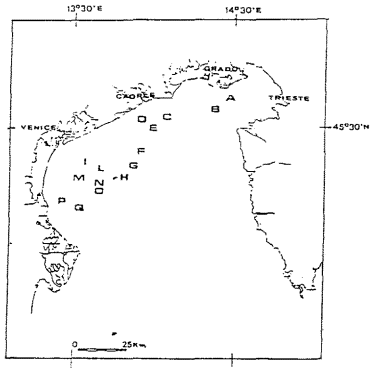


fig.1 - map of the zone

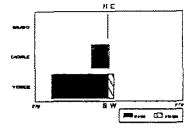
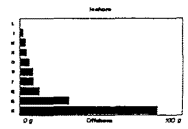


fig.2 - gradient of average abudance

fig.3 - gradient of abundance (tot. of 5 weighing)



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Determination of luxuriance of rolling *Calcareous thalli*

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The determination of the luxuriance of rolling calcareous algae has been the basis of a study of the Northern Adriatic circalitorial phytocoenoses dynamic (NICHETTO & BRESSAN, in presentation).

This study considered the vegetal forms present on the mobile bottom crossed by currents, offshore Grado, Caorle and Venice.

The species of the area are mostly free forms: *Lithophyllum racemus* (LAMARCK) FOSLIE, *Lithothamnium corallioides* CROUAN, *Phymatolithon calcareum* (PALLAS) ADEY et MC KIBBIN, *Spongites (Lithothamnium) fruticulosa* KUTZING and *Lithothamnion valens* FOSLIE.

The perennial and carbonatic structure of these algae make their presence possible in the sediment for many years.

Making a distinction between living and dead thalli is therefore indispensable for areal mapping.

Alga vitality or luxuriance can be estimated by the evaluation of:

- photosynthesis (production)
- reproduction
- developement (differentiation and growth).

But it is not very easy to determine the reproduction period of maërl species (conceptacles mainly immersed in the thallus) and its growth intensity (the dimensions vary with its age and also with its rolling capability). Therefore it seemed proper to observe the photosynthetic capability, which is easier to analyse.

Two series of analysis were made:

I period (1989-90): observation of:

a) oxygen production of in-situ incubating, by the Winkler method;

b) the status of the pigments (spettrophotometric analysis of Chlorophyll a and R-Phycoerythrins);

c) previous data elaboration.

The application of the methods required a calibration period, which showed that the usage of *Lithophyllum racemus* (more abundant in the different colours) is preferable.

II period (1991): search for proof of the results of the previous period, by means of a different approach which involves:

a) oxygen production measures, using the Clark electrode (DELIEU T. & D.A. WALKER, 1972; WALKER D.A., 1987);

b) chlorophyll extraction by N-N-dimetil-formammide and her subsequent spettrophotometric analysis at 730nm and 665nm;

c) weighing of the samples;

d) data elaboration.

This permitted the laboratory re-creation of the natural environment and the usage of the same thallus for the pigment analysis. The latter approach made possible the correlation of the oxygen quantity production with the pigment producer.

The results of the I period (tab.1) showed a different capability of oxygen production by R algae (code scale Seguy: 9, 14, 72, 74, 89, 105, 143, 148 red), from the B ones (code scale Seguy: 193, 199 white) and the G ones (code scale Seguy: 133 grey). Instead the M algae (code scale Seguy: 112, 131, 201 brown) demonstrated intermediate behaviour. The analysis of the pigments confirmed the sharp difference of viability between the R thalli and the others.

The results of the II period follow the same trend as the I set of analysis (tab. 2 & fig.1). The R algae were statistically (test of Student) separated from the M, B and G ones, on each day of analysis, from June to November.

Therefore we can conclude that only the R thalli can be considered alive.

In mapping the areas the proportion between the R and M, B, G ones should be considered to ascertain the greater or lesser luxuriance of an areal.

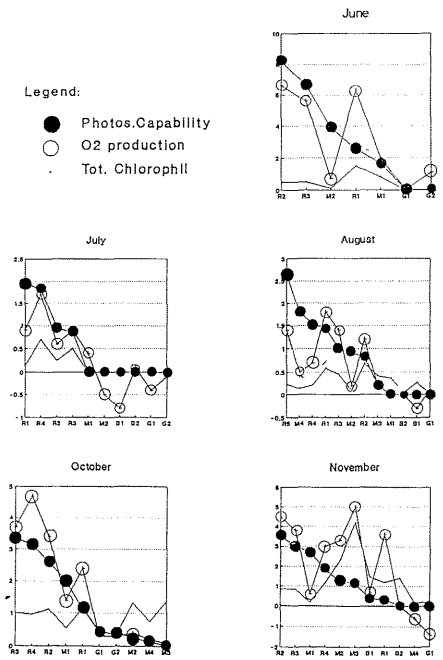

Fig. 1.- Grafic elaboration of data

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Production of Barnacles in a brackish lagoon in the Po delta

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On a evalué la production secondaire d'un peuplement à Balanes (*Balanus improvisus, B. eburneus, B. amphitrite)* dans une lagune saumâtre du delta du Po. La valeur de 51 $g/dm^2/an$ confirme l'importance de ce groupe d'animal dans la composition des communautés de la lagune.

Barnacles, represented by *Balanus improvisus* Darwin, *B. eburneus* Gould and *B. amphitrite* Darwin, form one of the most substantial parts of the macrobenthos of the hard substrate in the Po delta area and in particular of the "Sacca del Canarin" (RELINI *et al.* 1978-1985).

The Barnacles in the Po delta area have been studied since 1977 and among the published we would like to draw attention to : RELINI 1981; RELINI and FASCIANA 1982-1985-1989.

In order to estimate the secondary production of a population of three species of Barnacles in the Sacca a station was chosen at the centre of the lagoon, at a depth of 80 cm, which is greatly influenced by the marine inflow. For one year, from 1st June 1990 to 31st May 1991, cement-asbestos panels were immersed for periods varying from 2 weeks to 12 months.

Subsequently the central dm^2 of both sides of the panels was examined in order to evaluate the density, the size, the maturity of the individuals, the developmental stage of any possible embryos. The weight values of the whole of the fouling and of the share of Barnacles were expressed in terms of wet weight, dry weight and weight of ashes.

All three species show a summer-autumn recruitment. From June to October and beyond, only 2 week after being fixed on the substrate the Barnacle population already starts to contribute to the total biomass expressed in dry weight, and to the production of inorganic substances with percentages which are very often over 50%. During the study period the maximum value of the biomass was registred after 9 months of immersion, $68g/dm^2$, with a density of 278 $ind./dm^2$. On the annual panel a biomass of $55g/dm^2$ and a density of $282ind./dm^2$ was registered.

In order to measure the secondary production we applied two approaches suggested by CRISP (1971) for benthonic populations which do not present recruitment or applicable to any recruitment of species whose density and weight can be measured with continuity. The two formulas used are :

$P_1 = \Sigma_o^t N \Delta \varpi$

N= average number of individuals in the time interval.

$\Delta\varpi$= increase in average individual weight in the time interval.

$P_2 = N_t\varpi_t + \Sigma_o^t \varpi \Delta N$

$N_t\varpi_t$ = biomass present at time t.

ϖ = individual average weight.

ΔN= variation in density in the time interval.

The results were : P_1 =$54g/dm^2$/year and P_2=$50g/dm^2$/year.

In a Barnacle population the death does not correspond to the disappearance of shell of the Cirriped which remains stuck to the substrate.

In the theoretical population considered by Crisp, on the other hand, the density corresponded to the number of living individuals and mortality could be calculed theoretically as the difference in density between the two time intervals.

Thus, using real data of the number of living and dead individuals and giving a realistic estimate of the weight of a single living individual, a calculation was made, with the first formula, of a third production value P_3=$51g/dm^2$ year which falls into the previously estimated interval.

This value demonstrates the important role played by Barnacles in the ambit of the biocoenosis of this lagoon and confirms the high productivity of the northern zone of the Adriatic Sea.

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X

Some observations on the specific diversity of benthic macroalgae in the Northern Adriatic Sea

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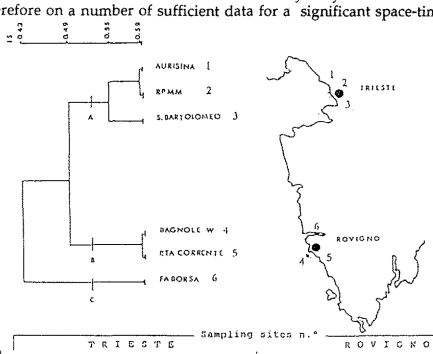
The study of macrophytobenthos is generally considered to be a useful reference (and even necessary) to the interpretation of space-time transformations of the sea environments. The object of this work is just that to bring into evidence some quali-quantitative modifications of algal flora in the Northern Adriatic Sea in comparison with the latitudinal expansion of the coast, and to understand the meaning of the aforesaid transformations. The sampling sites, chosen to start this kind of research, have been located near : Aurisina (1), Natural Reserve of Miramare (2) and S. Bartolomeo (3) in Trieste (Italy); Bagnole W (4), Punta Corrente (5) and Faborsa (6) in Rovinj (Croatia) (fig.1). The sampling was carried out in the years 1989-1990, at a seasonal cadence, in a bahtymetric interval that goes from mesolitoral level to inferior horizon of the infralitoral. the collected data have been arranged in a matrix, to which have been applied the cluster analysis.

On the basis of biotic classification relative to floral spectres (presence-absence of 191 species) in the different sampling sites, allowed the dendrogram (fig. 1) to bring into evidence, a clear-cut separation (IS < 0.55) among the sampling sites of Trieste (cluster A; IS = 0.55) and the ones of Rovinj (cluster B; IS = 0.59). The sampling site of Faborsa (cluster C; IS = 0.43), shows in this dendrogram a different position, due to the fact that in such a locality, owing to a unfavourable meteomarine conditions, hasn't been possible to carry out the autumnal sampling with the consequent loss of information. The difference of the floral spectres of the sampling sites, that has been taken into consideration, seems to bring into evidence a biotic distinction, which is characterized by : a) a progressive retreat of some species from the Gulf of Trieste (as, e.g.: *Sargassum hornschuchii* C. AGARDH, *Acetabularia acetabulum* (LINNEO) SILVA, *Sphaerococcus coronopifolius* STACKHOUSE and an isolation in small relict areas of others species, which instead were presented in the past (as, e.g. : *Cystoseira amentacea* BORY *var. spicata* (ERCEGOVIC) GIACCONE and *C. compressa* (ESPER) GERLOFF et NIZAMUDDIN *Hydroclathrus clathratus* (BORY ex C. AGARDH) HOWE, *Cladostephus spongiosus* f. *verticillatus* (LIGHTFOOT) PRUD'HOMME VAN REINE, *Peyssonnelia polymorpha* (ZAN.) SCHMITZ, *Posidonia oceanica* (LINNEO) DELILE); b) the recent appearence of species with wide spectre of ecologycal valence (*Codium fragile* (SURINGAR) HARIOT) in all the Gulf of Trieste. Infact this gulf, real and quite "cul de sac" inside of the Northern Adriatic Sea, is characterized, in comparison with the istrian coast, by: a leser water replacement and a larger sedimentary regime, besides by a different geology and geomorphology. These environment conditions are moreover those ones that must have helped the upstart of sciaphilous species from bionomical level below (BRESSAN *et al.*, 1991).

With the help of tab. 1, it was possible to bring into evidence: a) a relatively high value (4,0÷5,8) of biogeographical index R/P (1≤ R/P ≤4) by FELDMANN (1938), due to an increase of the percentage of *Rhodophyceae* and a parallel reduction on percentage of *Phaeophyceae*. Such index, that has been calculated also according to the different formulations of BOUDOURESQUE (1971) and of CORMACI *et al.* (1985), has turned out to be almost always out of scale (> 4) (tab. 1) and this, not so much why the Nothern Adriatic Sea is to be considered biogeographically "tropical", but because the value of such index, also on the basis of specialized scientific literature, seems to suffer the environment alterations, losing the initial property (FELDMANN, 1938) of corological characterization; b) a low number (≈ 10%) of eutrophyc tionitrofile species, which are typical of polluted areas, as e.g. *Enteromorpha intestinalis* (LINNEO) LINK, *E. crinita* (ROTH) J. AGARDH, *Codium vermilara* (OLIVI) DELLE CHIAJE, *C. fragile* (SURINGAR) HARIOT, *Ulva laeterivens* ARESCHOUG, *Pterocladia capillacea* (GMELIN) BORNET, etc.; c) a reduction of total number of species in comparison with the work of VATOVA (1928) in Rovinj and of GIACCONE (1967) in Trieste. Beyond the limits of comparison due to the methodologycal, instrumental and cultural differences, the objectiveness of this last observation will be trustworthy only on the basis of subsequent deepenings, therefore on a number of sufficient data for a significant space-time comparison.



Tax. divisions	TRIESTE 1 n.sp.	%	2 n.sp.	%	3 n.sp.	%	ROVIGNO 4 n.sp.	%	5 n.sp.	%	6 n.sp.	%	Tot. sp.
Rhodophyceae	65	67,7	72	69,2	58	69,0	83	69,7	81	71,1	36	62,1	
Phaeophyceae	14	14,6	13	12,5	14	16,7	17	14,3	14	12,3	9	15,5	
Chlorophyceae	17	17,7	19	18,3	12	14,3	19	16,0	19	16,7	13	22,4	
Part.tot.sp.	96		104		84		119		114		58		191
R / P (*)		4,6		5,5		4,1		4,9		5,8		4,0	
R / P avg (*)		4,7					4,9						
R / P avg (**)	4,2		5,8		3,8		5,7		6,4		3,1		
Q_R / Q_P (***)	4,2		5,8		3,9		5,7		6,4		3,2		

Sampling sites n.°

(*) by FELDMANN, 1938 - (**) by CORMACI and coll.,1985 - (***) by BOUDOURESQUE, 1971

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X

General characteristics of Benthic Flora of the Southern Adriatic

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Benthic flora of the Southern Adriatic had long been quite unknown if compared to much better studied flora of other parts of this sea.

We have compiled a list of species composition of benthic flora settlements of this Adriatic part from our long-term studies in different parts of this area. The list consists of 412 taxa of three divisions of benthic algae (241 Rhodophyta, 94 Phaeophyta and 77 Chlorophyta) and three species of marine phanerogams (SPAN and ANTOLIC, 1988) (Table 1). This paper presents some general characteristics of studied benthic flora from a part of the Peljesac coast to Ulcinj town, and some parts of the coast of islands Korcula, Mljet, Kolocep, Daksa and Lokrum.

Table 1. Review of species and infraspecific taxons of benthic flora from Southern and Middle Adriatic

	RHODOPHYTA N	%	PHAEOPHYTA N	%	CHLOROPHYTA N	%	TOTAL N
Southern Adriatic	241	58.5	94	22.8	77	18.7	**412**
Middle Adriatic	301	56.7	136	25.6	94	17.7	**531**

The inventory of benthic flora of the Southern Adriatic is poorer in comparison to the revised Middle Adriatic benthic flora (SPAN and ANTOLIC, 1989) which consisted of 531 taxa (301 or 56.7 % Rhodophyta, 136 or 25,6 % Phaeophyta and 94 and 17.7 % Chlorophyta) (Table 1).

The difference between Middle Adriatic R/P quotient of 2.2 and that of 2.6 from the southern Adriatic seems not to be great, particularly if the values from some principal parts of the Southern Adriatic were higher; 3.6 for Dubrovnik area (SPAN and ANTOLIC, 1991) and separately for Lokrum (SPAN *et al.*, 1989), 3.4 for open Monte Negro area (SPAN and ANTOLIC, 1983) and 3.2 for the bay of Boka Kotorska (ANTOLIC and SPAN, in press). Some data of biogeographical and bionomical distribution of Adriatic benthic algal taxa are used of GIACCONE (1977) check-list of Adriatic marine flora.

Benthic flora of both Middle and Southern Adriatic includes the elements of the same phytogeographical affinities, even though with different percentage presence. The atlantic-mediterranean (46.5 % and 50.2 %) and mediterranean (31.6 % and 30.8 %) elements are dominant in both the Middle Adriatic flora and Southern Adriatic flora making up 78.0 % and 81 % respectively. The adriatic (9.4 % and 6.1 %), indo-pacific-mediterranean (4.9 % and 6.1 %), cosmopolitan (3.6 % and 3.7 %), adriatic-atlantic (2.1 % and 1.2 %) and circumtropical (1.9 % and 2.4 %) elements constitute the rest of 22.0 % and 19.0 % respectively. High percent of the presence of adriatic elements and slightly poorer presence of atlantic-mediterranean elements in the flora of the Middle Adriatic is indicative of its better pronounced "Adriatic" character. On the contrary, higher percentage presence of the atlantic-mediterranean and lower percentage of adriatic elements in the flora of Southern Adriatic point out its rather mediterranean character.

The causes of rather modest development of benthic flora of the Southern Adriatic in comparison to the Middle Adriatic could be ascribed to very strong exposure of a larger part of the coast to the open sea unprotected by the islands in front. Depth distribution of benthic algae was hindered due to the formation of ample and uninterrupted surfaces of mobile bottoms, at times already at small depths near the coast. Typical and well developed coralligeneous settlements, encountered around outer islands of the Middle Adriatic, where rich deep flora of benthic algae is also well developed, are almost completely absent from the Southern Adriatic bottoms.

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Study of the effects of Makarska Port (Middle Adriatic) on the changes in benthic algal settlements

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A study of the zero state of benthic algal settlements in the wider area of Makarska Port were carried out in 1991 to provide the basis for forecast of possible effects of intended building of marina in this port.

The study was performed on a total of seven transects, three laid out in the port (zones B and C) and four out of it (zone A) on hard and sediment supralittoral, mediolittoral, infralittoral and partly circalittoral bottoms and a rather large number of additional stations in all the zones of study area (Fig. 1). Direct SCUBA diving method and indirect dredging method on 20-60 m depths were applied.

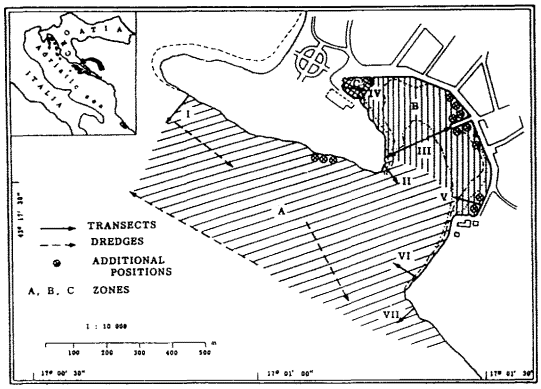

Fig. 1. Study area

A total of 269 taxa of benthic algae were determined: 172 or 63.9% Rhodophyta, 46 or 17.1% Phaeophyta and 51 or 19.0% Chlorophyta (Table 1). Obtained inventory is relatively rich but not typical for clean Middle Adriatic coastal waters. Their qualitative composition and structure resemble those of the settlements in the port areas and adjacent to them, where the numbers and percentages of Chlorophyta exceed those of Phaeophyta. Some earlier studies in different preserved Eastern Adriatic areas regularly reported prevalence of the numbers and percentages of Phaeophyta over those of Chlorophyta.

Of the total of 269 determined taxa, 252 were distributed out of the port (zone A) whereas the number of determined taxa was 130 in the zones B and C, not exceeding 48 taxa in zone C (Table 1). Settlements wherefrom 102 taxa of benthic algae were determined, were formed between 20 and 60 m on detritic-sandy bottoms of the zone A. This is indicative of the fact that they were not exposed to the pollution of the port waters. Marine phanerogams are almost completely absent from the study area; a poor settlement of *Posidonia oceanica* was recorded from 15 m depth at transect V.

Comparing the data on species composition and structure of benthic algal settlements in the Makarska area to those in the Split area (SPAN and ANTOLIC, unpublished results) showed far smaller number of taxa in the latter area (169), 163 in zone A and 48 in zones B and C, and only 25 in zone C (Table 1), even though it is much larger and better seasonally studied area. Presented data show that changes in the benthic algal settlements have the same trend in both study areas, but that their extent and intensity are not so pronounced in Makarska.

To conclude, even though the pollution level in the Makarska port area is lower than in the Split port area its extent caused the regression of benthic algal settlements so that present situation calls for their protection and healing.

Table 1. Numbers (N) and percentages (%) of benthic algae taxa in the wider area of Makarska and Split ports (zones:A - out of the port; B - inside the port; C - special transect in the western most part of the port) and throughout the study area (T)

ZONES:	A		B		C		T	
	N	%	N	%	N	%	N	%
Makarska port								
RHODOPHYTA	164	65.1	83	63.8	27	56.3	172	63.9
PHAEOPHYTA	41	16.3	20	15.4	7	14.6	46	17.1
CHLOROPHYTA	47	18.6	27	20.8	14	29.1	51	19.0
TOTAL	252		130		48		269	
Split port								
RHODOPHYTA	91	55.8	23	51.1	9	36.0	97	57.4
PHAEOPHYTA	35	21.5	9	20.0	1	4.0	35	20.7
CHLOROPHYTA	37	22.7	13	28.9	15	60.0	37	21.9
TOTAL	163		45		25		169	

Note on the biology of *Carcinus aestuarii* (Crustacea, Decapoda, Brachyura) in the Rovinj area

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The Mediterranean shore crab *Carcinus aestuarii* NARDO, 1847 is fairly scarce in the Rovinj area, and only sparse data on its ecology in the area exist (FORSTNER, 1967). Studies of the species in the area had been performed in 1976-1978 at shore in Ruja Cove near the hospital on the Cape Muca (Mucia) (present results), and later in the 1981-1991 period in seagrass beds of Leso (Lesso), Ruja and Saline coves (STEVCIC, in press).

Locality and collecting. In the Ruja Cove the shore crabs were sampled monthly by hand in the intertidal zone during the low tide. 340 specimens were collected in this locality on the following dates:

Date	Males	Females	Date	Males	Females
09. 11. 1976	10	06	19. 07. 1977	17	08
21. 12. 1976	02	04	17. 08. 1977	32	04
17. 03. 1977	11	07	13. 09. 1977	20	19
21. 04. 1977	17	23	27. 09. 1977	18	13
06. 05. 1977	15	11	26. 10. 1977	07	11
24. 05. 1977	13	23	27. 12. 1977	07	01
21. 06. 1977	12	18	06. 04. 1978	06	05

Sex ratio and laterality. Among 340 specimens 187 were males and 153 females. Thus sex ratio is 1,22. The majority of specimens had the right cheliped as the major one (149 males and 104 females). 26 specimens had left cheliped as the major one (12 males and 14 females), whilst only in one case the laterality was indistinct.

Population changes. Specimen abundances varied during the year. Crabs were more frequently observed from April to October, while from October to second part of April the crabs were rare or nearly absent. During the colder period (October-April) an increased number of crabs in the seagrass beds was not observed (STEVCIC, in press), and there was also no indication of their migration into the deeper sublittoral. The crabs were, however, observed to enter the holes in the substrate or galleries (burrowed by themselves or by thalassinids?), and, moreover, digging into the substrate.

Size. Carapace width in males varied from 7,9-48,7 mm, and in females from 11,2-42,8 mm. The Rovinj area shore crabs are relatively smaller in comparison with other Adriatic areas e.g. Venice Lagoon, or mouth of Krka River in Dalmatia (unpublished data).

Habitat. The shore crab prefers a soft sedimentary substrate (FORSTNER, 1967), almost muddy bottom and seagrass beds, in particular where the water is more or less brackish. It occurs as in the intertidal zone, usually under the boulders, as in the shallow sublittoral waters. It is observed, quite unexpectedly, that greater specimens, when emerged during low tide, are nearer to low tide mark, whereas the smaller ones are nearer to the upper tide mark.

Reproductive cycle. Since the crabs are relative rare, usually concentrated in some limited areas, it was impossible to follow their reproductive cycle in its entirety. The ovigerous females were rarely recorded during February, March and September. The copulation occurred in April, when the couples of male and female were observed. From April to May the specimens were often gathered in groups.

Molting period. The specimens with soft integument i.e. immediately after molting were observed relatively often, but usually only one specimens per sample. Only on 21 April 1977 were found 11 moulted (out of 30) specimens, and on 17 August 1977 were found 4 (out of 34) specimens.

Foregut fullness. The foregut (stomach) analysis was performed on 280 specimens, 123 foreguts resulted empty. In the remaining 157 specimens the percentage of foregut fullness is presented in the next table:

Percentage of fullness	No	Percentage of fullness	No
01 - 10	47	51 - 60	5
11 - 20	39	61 - 70	6
21 - 30	16	71 - 80	7
31 - 40	12	81 - 90	13
41 - 50	10	91 - 100	2

Food composition. The analysis of food composition found in the foregut shows that the Rovinj area crab feeds on various food items. The most frequent component of the foregut content was an amorphous organic matter (66 times). Among recognizable parts, bivalve mollusks (almost mussels) were observed 46 times. Polychaetes follow with 32 times. The next group were the decapod crustaceans, predominantly crabs (19). Plant remnants were more rarely identified, various algae (14), whereas higher (vascular) plants were found only once. Gastropods were recorded 11, and polyplacophors 6 times. Among small crustaceans amphipods were found 9 and isopods only three times. Detritus was found 10 times, sand particles 14 times and small stone particles 3 times. These date show that this species is an opportunistic omnivore, that feeds predominantly on sessile and slowly moving animals, whereas quickly moving animals are rarely eaten.

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X

Benthic foraminiferal density and faunal composition in the Southern Adriatic Sea The relation with the expected downward organic flux

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Assemblages of living (Bengal rose stained) benthic foraminifera were examined from the top 1cm of sediments from the shelf, slope and deep basin of the Southern Adriatic Sea, recovered in box-cores during cruise AD-91 of the Istituto di Geologia Marina of Bologna, in March 1991.

Over the depth-gradient covered by sampling, ranging from 146 m to 1200 m waterdepth, some remarkable changes can be noticed in the overall abundance and composition of benthic foraminiferal fauna's, which may reflect changes in the quantity and quality of the supply of organic food to the benthic ecosystem.

An overall decrease is observed in the abundance of living benthic foraminifera going from the shelf down into the deep basin. Assuming that the abundance of epifaunal foraminifera is proportional to the flux of organic food arriving at the seafloor, which flux according to SUESS (1980) is an inverse function of waterdepth (z), we tested if benthic foraminiferal abundance can be described as a function of 1/z.

The overall decrease in foraminiferal abundance with depth did not match the expected 1/z relationship. After subdividing the fauna in a group of non-opportunistic calcareous perforate taxa, a group of opportunistic calcareous perforate taxa, and a group of arenaceous and miliolid taxa, however, a fairly good correspondance was found between predicted and observed foram abundances for the first-mentioned group (Fig. 1). Notable discrepancies are seen on the steepest part of the basin slope, which has smaller populations than expected, and at the base of the slope, which has larger than expected populations. This phenomenon may be explained by downslope displacement of organic matter.

Opportunistic calcareous perforate taxa (among which species of *Bolivina, Bulimina* and *Uvigerina* are dominant) are most abundant on the shelf, where they compose almost one-third of the total fauna, but decrease rapidly both in absolute and relative number in the deeper water. It may be speculated that these taxa thrive on the short bursts of fresh organic detritus available in the shallow shelf waters.

The group of arenaceous and miliolid taxa, on the other hand, becomes increasingly dominant towards deeper water, and notably the epifaunal tree-like *Rhizammina* is very abundant at the base of the slope and in the deep basin. This clearly reflects the commonly observed shift from predominantly deposit-feeding foraminiferal faunas in shallow waters where food abounds to predominantly suspension-feeding faunas in deeper waters with a more scarce food regime (JONES and CHARNOCK, 1985).

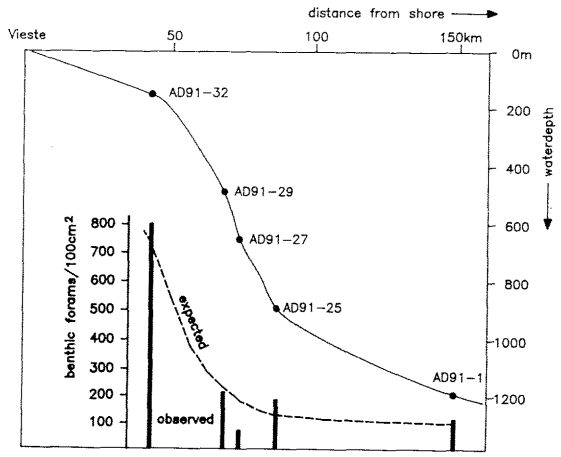

Figure 1. Bathymetric profile of the studied depth-transect, with box-core sites indicated. Bars below sites indicate the observed abundance of non-opportunistic calcareous perforate foraminifera, dashed line represents the expected abundance.

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Recovery of benthos after an anoxic stress. III. Meiofauna

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Response of meiofaunal communities to environmental perturbations, have been less studied than those of the macrofauna, despite of numerous advantages over it (HEIP *et al.*, 1988). Absence in meiofaunal response to seasonal anoxia (GRAY *et al.*, 1988) one can explain by less sensitivity of meiofaunal taxa, or faster recovery time in comparison to macrofauna. Heavy disturbance in meiofauna community structure, provoked by anoxic stress noted in the eastern and central part of North Adriatic, suggested the accuracy of the first possibility. Comparative analyses, carried out in November 1989, immediately after the stress detection, showed a stirring response of meiofauna to anoxic conditions. It was expressed by drastic decrease in nematodes (Ne) copepodes (Co) and total meiofauna densities, a significant increase of Ne/Co ratio, and in an expressive dominance of nematodes in relation to other meiofaunal taxa (TRAVIZI, 1990).

Recovery of meiofauna has been monitored at station SJ-005 (45° 18.4' N, 13° 08.0' E), about in the middle of the area which suffered from bottom anoxia in the autumn 1989. The station is characterized by the 30 m depth, and silty-sand sediment.

According to our results, the recovery of sediment meiofauna consumed a fairly short time, and it occurred very swiftly. Yet about six months after the stress, meiofaunal community structure showed insignificant signs of improvement. Abundance values of main groups remained fairly stable, and manifested only a very slow increase until June 1990 (Fig. 1), when total density increased nearly six times related to that of the preceding month. The Ne/Co ratio, still was distinguished by a very high value.

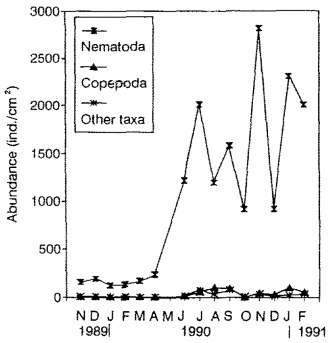

Fig. 1. Densities of meiofaunal taxa in recovery period 1989-1991.

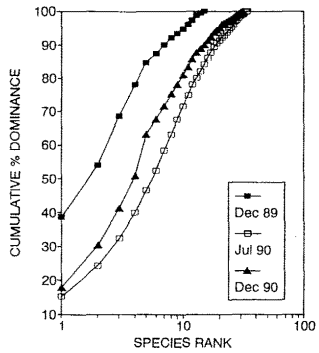

Fig. 2. Recovery steps of nematofauna associations at station SJ 005.

In July, the signs of intensive recovery were noted in nematodes, copepodes, and other taxa densities, and in decrease of percentage nematodes participation in total meiofauna. Total meiofauna and nematofauna densities increased more than 70 %, so in comparison to densities registered immediate after the stress event amounted about thirteen times higher values. Contemporary, copepoda abundance increased about ten times, while Ne/Co ratio decline from 226 to 38. In August a phase of stabilization was achieved, i.e. a phase of normal density oscillations, shortly intensified in October, when hydrographical data suggested the appearance of hypoxia. In December 1990, the oxygen depletion was not registered, but according to structural changes in meiofauna community, it seemed that hypoxia occurred, although it was less expressed, and perhaps shorter in time than one year ago.

The process of nematofauna recovery showed evolution strategy similar to that of total meiofauna. After the initial period of recovery, the species number increased more than 100%. Species dominance decline, and all diversity indices, increased and stabilized, suggested the reestablishment of dynamic ecological balance. The changes in shape and position of k-dominance curves indicate the apparent tendency to a associations recovery. According to some changes surveyed after the subsequent hypoxia appearances, the established equilibrium is not so stable to stand a test of a long-term, or an expressive oxygen depletion.

It is possible that repeated oxygen depletions, which in the North Adriatic recently increased in frequency, resulted in certain modification of benthic communities, in sense of increasing resistance toward certain levels, and duration of oxygen deficiencies. It seems that shortlived hypoxic conditions, as a slightly form of oxygen subsaturation, not significantly influence to meiofaunal community structure, and that could be espied only by repeated, monthly sampling.

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X

Nematofauna in North Adriatic offshore sediments

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In the Adriatic offshore sediments, the free-living nematofauna assemblages remained scarcely known until now, and their structural compositions were not studied comparatively.

To overcome the gap, in September and October 1991 the nematofauna had been sampled at six offshore stations characterized by silty-sand (stations SJ-005, 007, 107), and by silty clay or clayed-silt sediment, enriched by sandy fractions (station SJ-101, 103, 108) (Fig.1). According to TIETJEN (1977), sediments composed by different ratio of silt and clay components (64-75%), were classed as mud. The sediment was sampled by SCUBA divers by means of plastic hand corers, 3.5 cm inner diameter. Three replicate per station were taken, and processed according to standard methods (VIDAKOVIC, 1987). For taxonomic purposes, 200 specimens per station were studied.

In muddy sediments, 15 free-living species were noted at each station. At stations characterized by silty-sand 30-36 species were identified. The QS at muddy group of station varied from 67 to 73 %, and at silty-sand from 59-70 %, respectively. Between the stations of different sediment types, the similarity calculated was only 31-54 %.

At all stations, a significant dominance of few species were noted. At muddy stations, 7 species (abundance > 5 %) share by 20-33 % in species composition, and 78-87 % in nematofauna density. At silty-sand group of stations, in total 14 abundant species were identified, but their dominance was less expressive, and they were more evenly distributed among the codominant species. A joint mark of nematofauna assemblages at particular sediment type, i.e. mud or sand, was an expressive dominance of only three species at silt-clay bottoms, and a relatively high abundance of eight species at silty sand bottoms. In general, our results are in accordance with conclusions of TIETJEN (1977), and notes of VIDAKOVIC (pers.com.) on nematofauna composition species at similar types of sediment in coastal areas.

At muddy stations, an expressive dominance of non-selective deposit-feeders (1B) was established. This group prevailed at silty-sand stations too, except at station SJ-007, at which a dominance of epigrowth-feeders (2A) was noted. In silty-sand sediment, however, a relatively high share of omnivorous and predatory (2B) species was find out.

Consequently, because of low participation of 2A category at silty-sand stations SJ-005 and 107, the predominance of 2B species over them, and some peculiar features of meiofauna and nematofauna species compositions, it seems that, besides the sediment granulometry, the eutrophication conditions involving in the area in past decade, also could play an decisive role in determining the nematodes assemblages compositions.

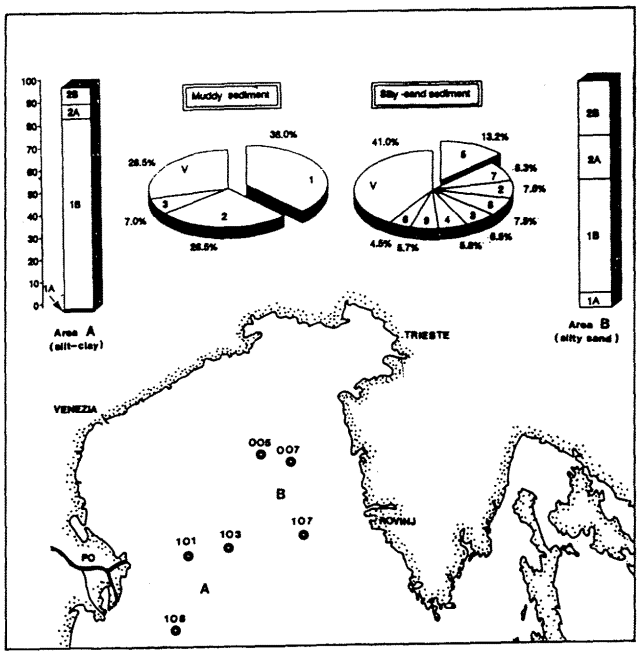

Fig. 1. Nematofauna composition. Species 1- *Dorylaimopsis mediterranea*, 2- *Sabatieria proabyssalis*, 3- *Actarjania* sp., 4-*Rhabdodemania mediterranea*, 5- *Pomponema multipapillatum*, 6- *Halichoanolaimus dolichurus*, 7- *Hopperia* sp., 8- *Axonolaimus* sp. 9.- *Sphaerolaimus dispar*, V- other species (abundance < 5%).

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The Strunjan Nature Reserve - Main features and role

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The Gulf of Trieste is a shallow marine ecosystem where characteristics of the coastal and open waters of the Northern Adriatic are combined. With few exceptions the depth of the gulf does not exceed 25 m. Because of its shallowness and the freshwater inputs as well, the waters of the Gulf experience considerable temperature and salinity variations. The tides, compared to the modest tidial amplitudes in the rest of the Mediterranean Sea, can be considered remarkable (OLIVOTTI *et al.*, 1986). All this features make out of the gulf of Trieste a quite unique ecosystem. Unfortunatly there is another characteristic, a gained one, that is threatening the uniqueness of the northernmost part of the Adriatic. Namely the intensive urbanization of its coastline and in consequence a serious degradation of the coastal ecosystems. The same goes of course for the 46 km of the Slovenian coast which is built-up mainly of flysch (shaped as high cliffs), of alluvial or sea sediments and as an exception of limestone. There are less than eight kilometers of natural coastline (SVETLICIC & KRIZAN, 1985), accidentally left aside by the onsloughts of urbanization. Half of it is represented by small parts of seashore randomly distributed from Debeli rtic to Savudrija and there is only one major part of natural coastline left between the town of Izola and Piran.

As it is difficult in such circumstances to ensure the protection of the marine environment, though it relies upon a whole series of legal instruments, underwater reserves and other protected areas act as a kind of safety barrier, maintaining or restoring the quality of that environment in areas that are particulary sensitive or of outstanding interest. There are three marine protected areas on the Slovenian coast. Two smaller ones - the underwater natural monument around Madona promontory in Piran and the natural monument Debeli rtic and the largest one - the Strunjan Nature Reserve, promulgated in January 1990.

The Strunjan Nature Reserve is a coastal and marine reserve. It covers the Northern part of the Strunjan Peninsula together with its 3.800 m long coastline and a 200 m wide sea belt. The steep flysch cliffs can be as much as 80 m high and are the highest flysch cliffs on the East Adriatic coast. There is a great variety of different geological and geomorphological features due mostly to the flysch structure and the inclination of layers (folded strata, microtectonical faults) but also to the different forms of erosion (calcareous sinter, cliff-foot caves, boulders) the latter being enhanced by the Northern exposure of the coast. The vegetation of the area is tipically submediterranean and is represented mostly by a dense *Seserio - autumnalis ostryetum*. Very frequent also the *Arundo donax* and the spanish broom (*Spartium junceum*). Of great botanical interest the steep cliff edge above the Ronek promontory where representative of the evergreen eumediterranean vegetation are thriving amidst the deciduous submediterranean one. For two species, namely *Mirtus communis* and *Arbutus unedo*, common in the mediterranean maquis, the promontory represents probably the only autochtonous growing place in Slovenia (WRABER, 1972).

The sea bottom is rocky at first and silted later. The results of a preliminary inventory and topography of marine flora and fauna that was carried out in 1991 (VUKOVIC *et al.*) are showing a great diversity of marine organisms that are representing a mixture of mediterranean and boreal species. The fact is enhanced also by the absence of direct pollution of the area and as a result by the more or less natural ecological processes on both sides of the coastal line. To point out the Moon Bay, because of its *Cymodocea* and *Zostera* prairie with single subjects of *Pinna nobilis* and *Spirographis spallanzanii* and the Ronek promontory with its dense and diversified algal vegetation (TURK, 1991).

In order to protect the area from excessive and harmful disturbances the promulgation decree among other prohibits to : dump rubbish of all kinds, intervene so to cause degradation of the living conditions for plants and animals on land and in the sea, gather, uproot or destroy plants, pick up seeds and fruits, collect sea organisms and to fish with the exception of angling, hunt or collect animals, enter non-autochthonous plants or animals, destroy or damage nests and other living spaces, cause noise, explosions and vibrations, make a fire and navigate and anchor in the area between the promontories of Strunjan and Ronek from the 15th of June to the 15th of September.

As it was mentioned above, marine and coastal reserves so as other protected areas represent an important tool in the struggle for a sustainable use of natural resources. The intensive urbanization of the coastline of the Gulf of Trieste calls for a whole network of protected areas in order to stop and reverse the degradation of single marine and coastal ecosystems and of the gulf as a whole. The Strunjan Nature Reserve, being the largest marine reserve in the gulf could be an important link in this network.

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X

Cycle reproductif et aspects de la biométrie chez *Laevicardium oblongum* (Chemnitz) du Golfe de Trieste.

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Abstract

Laevicardium oblongum is a species hermaphrodite caracterized from a long period of reproduction that occur from February till August. The growth is allometric and different condition indices are discussed and compared.

Dans le cadre d'une série de recherches sur la biologie des Mollusques Bivalves, on a étudié la reproduction et la biométrie chez *Laevicardium oblongum*, espèce commune sur des substrats détritiques-sableux du Golfe de Trieste et avec une vaste zone de distribution méditerranéenne et atlantique mais qui n'a été, à notre connaissance, l'objet d'aucun travail. Sa pêche est quelque peu limitée. On a recueilli, de septembre 1987 à septembre 1988, tous les mois, deux cents exemplaires provenant de pêches faites dans le Golfe de Trieste. On a mesuré, avec un pied à coulisse, la longueur de coquille de tous les animaux et sur 50 exemplaires, choisis au hasard, ont été déterminés la hauteur, l'épaisseur et le poids total, celui des parties molles et des valves vides. Les parties molles de 20 exemplaires, choisis au hasard, ont été fixées au Bouin, coupées (6 µm) et colorées à l'hematoxyline-éosine. Les gonades ont été classées selon une échelle histologique de 6 Stades, déjà adoptée au cours d'une précédente étude (VALLI *et al.*, 1990) chez une autre espèce de Cardiidae, *Acanthocardia aculeata*. Les Stades sont les suivants: Stade 0 (repos sexuel), Stade 1 (début de la gamétogenèse), Stade 2 (développement), Stade 3 (maturité), Stade 4 (émission), Stade 5 (fin du cycle). Nous avons ensuite calculé l'indice gonadique selon SEED (1980) qui synthétise par une seule valeur par mois la condition des gonades. Sur les animaux restants on a déterminé le poids sec de la chair (étuve à 105° C), le poids des cendres (four à 550° C) et, par différence, le poids sec sans cendres et, enfin, on a déterminé le volume intérieur des valves. La gonade de *Laevicardium oblongum* est hermaphrodite et l'émission synchrone des gamètes des deux sexes arrive surtout de février à août mais elle est particulièrement intense d'avril à août. En septembre jusqu'à décembre les animaux sont en gamètogénèse et la maturité sexuelle arrive en février-mars. On a observé seulement un petit nombre d'animaux en repos sexuel en septembre. L'intense activité gonadique chez *Laevicardium oblongum* du Golfe de Trieste est soulignée par l'indice de condition de SEED qui présente des valeurs comprises dans l'intervalle 1-2.45, qu'on peut considérer moyennes ou moyennes-hautes (les valeurs théoriques sont 0, lorsque tous les individus sont en repos sexuel, et 3, s'ils sont tous mûrs). Par conséquent l'espèce adopte une stratégie reproductive que LUCAS *et al.* (1978) appellent type "r", à savoir caractérisée par un grand effort reproductif, qui est favorisé par des conditions optimales de température, salinité, oxygène, nourriture du Golfe de Trieste (MILANI *et al.*, 1988). Mais le fait qu'une espèce suive une telle stratégie peut être expliqué soit par une faible densité de population, qui rend difficile la rencontre des gamètes dans l'eau, ou par une mortalité élevée surtout larvaire. En effet la densité observée par VIO (information personnelle) est inférieure à un individu par mètre carré. Pour ce qui concerne la biométrie, la longueur moyenne des tous les animaux est de 4.68 cm, avec un intervalle de 2.88 - 6.25 cm. Les coefficients mensuels d'assymétrie de la longueur sont presque toujours négatifs, à savoir: la distribution de la longueur présente un nombre plus grand d'observations supérieures à la moyenne. Cette situation est due au fait que les animaux provenaient de la pêche professionnelle qui emploie des engins qui ont une sélectivité propre et, par conséquent, ne pêchent pas normalement les animaux inférieurs à 2.88 cm. Les valeurs mensuelles de la curtosis sont normales, sauf pour les mois de septembre, novembre, décembre 1987 et avril 1988. Avec le coefficient de variation pourcentage (CV%), paramètre indépendant de l'unité de mesure, il a été possible de comparer la dispersion de variables non homogènes. On a pu observer que les variables linéaires présentent une moindre dispersion à l'égard des pondérales (test de Wilcoxon). Le même test ne fait pas ressortir de différences significatives, parmi les volumes des deux valves, sauf pour les exemplaires de septembre 1987 et mai 1988. Pourtant on peut considérer que la coquille de *Laevicardium oblongum* est, substantiellement, équivalve. Ensuite on a calculé des régressions fonctionnelles (Modèle II) qui sont, partiellement, reportées ici pour permettre des évaluations:

Dep./Ind.	n.	r^2	a	b	interv. de b à 95%
H/L	482	0.94	-0.0563	1.2184	1.1912-----1.2456
E/L	485	0.91	-0.2567	1.2267	1.1923-----1.2584
PT/L	457	0.90	-0.6830	3.4351	3.3371-----3.5331
PV/L	466	0.93	-1.1145	3.5734	3.4850-----3.6618
PPM/L	479	0.85	-1.0985	3.4401	3.3204-----3.5599
PS/L	289	0.77	-1.9057	3.5679	3.3704-----3.7655
PSSC/L	269	0.76	-1.9916	3.5929	3.3830-----3.8028

(où: H = hauteur, L = longueur, E = épaisseur, PT = poids total, PV = poids valves, PPM = poids parties molles, PS = poids sec, PSSC = poids sec sans cendres; intervalle de b à 95% pour tester l'allométrie de l'accroissement. Données transformées en log10).

Les études de ces régressions et surtout celui des régressions mensuelles et l'analyse de la covariance (non discutées ici pour des raisons d'espace) permettent de connaître les variations de la croissance. Là, on se limite à observer que, relativement aux intervalles de mesures effectuées (de 2.88 à 6.25 cm de longueur), il y a une relation d'allométrie pour toutes les variables. On a comparé aussi 23 indices de condition: il s'agit de rapports qui dérivent des variables linéaires, pondérales, etc., avec pour but de repérer lequel ou lesquels sont à sélectionner pour suivre les fluctuations saisonnières des parties molles. Pour cette raison on a étudié la variabilité intérieure des divers indices, avec l'aide de tests non paramétriques (test de Friedman et test de Wilcoxon), et on a pu ainsi ranger les indices en ordre croissant de variabilité (les indices les meilleurs ont une petite variabilité). Puis, on a examiné (test de Kruskal-Wallis) la sensibilité des indices, à savoir la propriété d'élever les différences dans divers mois, et on a mis en évidence (test de Spearman) les indices qui présentaient des corrélations significatives avec l'indice gonadique de SEED. De l'intégration des résultats obtenus, on a isolé 3 indices: PS*100/(L+H+E) 3, PS/(L*H*E) et PSSC/(L*A*E) qui ont révélé les plus petites variabilités intérieures, les plus grandes sensibilités et les meilleures corrélations avec le cycle reproducteur. Ces indices se prêtent aussi à un but pratique pour évaluer le contenu édule et les moments les plus favorables pour le consommateur et pour différencier commercialement les animaux de cette espèce mais de différentes provenances: naturellement ces résultats ne peuvent pas être appliqués à n'importe quelle espèce sans des études préliminaires (BODOY *et al.*, 1986; VALLI *et al.*, 1988).

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Hypoxic bottom water and meiofauna in the Gulf of Trieste

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The Gulf of Trieste (Northern Adriatic), a semienclosed system, is characterized by a thermohaline stratification throughout much of the year (April - October). Morphologically, the Gulf is a flat submarine plain about 20 - 26 m deep in its central part sloping more steeply to shallower depths in the NW part. Surveys over 20 year period indicated that the central part of the Gulf is frequently distressed by oxygen depletions in the bottom layer. A comparison of the bottom layer dissolved oxygen concentrations gave significantly (t-test, $p < 0.05$) higher values closer to the coast at depths 20 m. Seasonal hypoxia of the bottom layer may exacerbate to anoxia, verified in late August-September of 1974, 1980, 1983, 1987 and 1990, leading to macrobenthic mortalities.

A meiofaunal survey of the southern part of the Gulf during August 1985 (VRISER, 1991) releaved higher abundances along the coasts spreading into inner parts of muddy bays (1500-2400 ind./10 cm2), and decreasing towards open north Adriatic waters and the central part of the Gulf of Trieste. Reduced abundances were most marked (464 ind./10 cm2) at the station in the centre of the Gulf.

Analysis of the meiofaunal material collected during 1985 showed 71 species of harpacticoid copepods which ranked the second most abundant after nematods. Horizontal distribution of harpacticoid abundances roughly followed that of total meiofauna, though with less marked increase towards the coasts and muddy bays. In contrast, towards the central part of the Gulf, the reduction was even more obvious than for total meiofauna. The result of the diversity (Harpacticoida) analysis was much the same: the majority of stations showed Shannon-Weaner indices between 2.4 and 2.6, which were reduced to 2.26 in the central Gulf of Trieste. A similar horizontal distribution was found for macrobenthic biomass in 1974 (FEDRA *et al.*, 1976) which showed a drastic decrease of wet weight from 300 g/m2 to 10 g/m.

The severe hypoxia registered in September 1990 greatly influenced the macrobenthic community, especially Echinodermata, Ascidiacea, Spongiaria. A survey in the area where oxygen saturation dropped below 10 % showed nearly halved meiofaunal abundances. A year later (September 1991) the meiofaunal abundances returned to values registered in 1985.

These results lead us to the conclusion that there exists in the deeper, central part of the Gulf an "anoxic depression", affected by recurring oxygen depletions and characterized by reduced macrobenthic and meiobenthic abundances, as well as lower diversities. On the other hand, our data indicate that meiofauna may survive short periods of severe hypoxia, which has catastrophic consequences for macrobenthos. Moreover, even when meiofauna suffered mortality, it returned to nearly normal abundances in about one year, though some structural changes may appear.

It seems that reduced vertical mixing and specific hydrodynamic conditions in the deeper parts of the Gulf of Trieste set the stage for severe hypoxias. From several hundreds of separate measurements (STRAVISI, 1987), it was shown that the circulation in the Gulf is mainly wind driven, with a vertically averaged velocity of ~ 10 cm/s. Generally, with easterly winds ("bora" ENE) the whole water column is moving counterclockwise. The layer below 10 m is moving almost permanently counterclockwise, with typical transport velocities of 2-3 cm/s. Tidal currents (mean velocities 3-10 cm/s) are most significant in calm weather, but they just move virtually the same water mass forward and backward along the axis of the Gulf. The circulation of the bottom layer in the middle of the Gulf, where depths are 22 m, were not measured so far. But, we can reasonably conclude that the circulation of this layer is even weaker than that in the bottom layers surrounding the central part, especially during the summer when westerly winds are more frequent. In this case, momentum of the upper layer drifted by westerly winds can be balanced by motion in opposite direction in the intermediate layer, leaving the bottom layer almost uncoupled from the motions above and alongside.

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Microphytobenthic chlorophyll biomass in the Gulf of Trieste (Northern Adriatic)

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Microphytobenthos, that is sediment associated microflora, have recently been recognized as important primary producers in shallow nearshore areas. While phytoplankton structure, biomass and production as well as benthic macroalgae have been extensively investigated in the Gulf of Trieste little attention has been paid to benthic microflora.

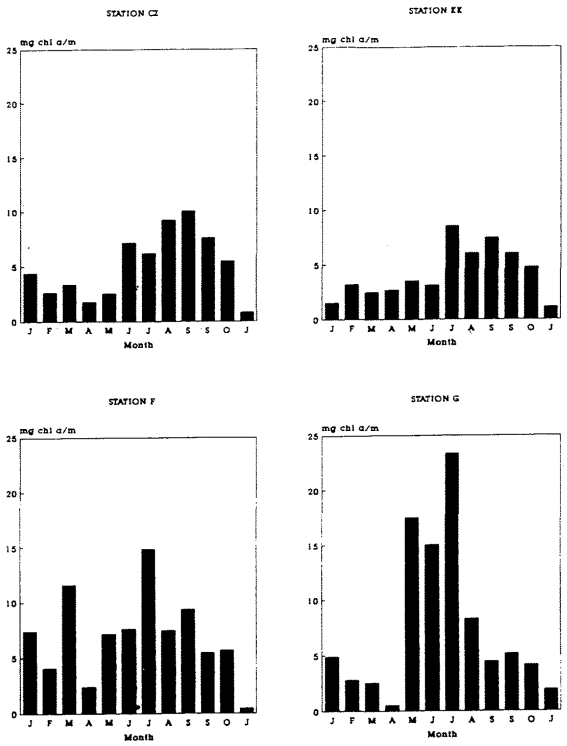
Within Alpe-Adria campain we have followed microphytobenthic biomass with approx. monthly frequency at four locations having depths 20 to 22 m. Sediment was sampled with a gravity core sampler and the top 1 cm was used for analyses. Chl *a* and phaeopigment were determined following the procedure 2 described by SUNDBACK (1986). Chl *a* values varied between 0.47 and 23.37 mg/m with lower values found at locations in the central part of the Gulf of Trieste (stations KK, CZ). At these stations the variations were moderate (mean 4.68 mg/m2, SD 2.60), while higher values with larger variation were measured at the entrance into the Gulf (stations F, G; mean 7.25 mg/m2, SD 5.65).

Generally, at all stations the highest microphytobenthic chl *a* biomass occured in "summer clear waters", that is during the period with favourable temperature and light conditions (Fig. 1).

The phaeopigment contents of the sediment varied between 1.29 to 80.84 mg/m and also showed peak values in summer, partly reflecting increased sedimentation of phytoplankton. This is also indicated by increased sedimentation rates measured during this time of the year (POSEDEL & FAGANELLI, 1991).

Microphytobenthic chl a was generally lower than respective value of the phytoplankton representing from 5 to 60 % of the total chlorophyll a at particular station; larger propo~tions of total chl a due to benthic microalgae were recorded in July (> 40 % at all stations). However, higher concentrations observed during summer-autumn may partly originate from sedimentation of viable phytoplankton cells.

The differences observed among the stations could not be attributed to different nutrient and transparency conditions and we belive that besides sediment type and particular hydrodynamic conditions (causing accumulations of microphytobenthos at some areas) the disturbance of the sediment due to human activities (fishing with beam trawl) may control the distribution of benthic microalgae.



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Polychaeta trophic groups in some offshore Biocoenoses in the Northern Adriatic

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Offshore polychaeta in the Northern Adriatic have not been explored so far, from the trophic viewpoint, though among the benthos organisms they particularly indicate the highest degree of the trophic - functional adaption, and they are included into nearly all levels of the trophic steps in the sea.

Identification of the trophic groups and their nomenclature is based on the works of FAUCHALD and JUMARS (1979) and MAURER and LEATHEM (1981). The suggestion of GAMBI *et al.* (1982) has been taken into consideration, and the new group "omnivores" has been introduced.

The polychaeta fauna has been stated from three Biocoenoses: from Coastal terrigenos ooze; Coastal detritic and from Coastal detritic mixed with ooze. Among total 88 species of polychaeta with 5536 samples it has been established 13 trophic groups. On the explored bottom of the Northern Adriatic offshore, the most numerous are the polychaeta which feed with detritus and with organic mud digging and burrowing in the sediment. The greatest abundance is showed by the group BMX (Burrowers, Motile, non-Jawed) 50.7%, thank to species *Notomastus latericeus* and *Sternaspis scututa* which make 50.5% of the total number of the units. All other groups are following behind this like SDT (Surface, Deposit-feeders Discretely motile, Tentaculate) 7.3%, in which dominates the species *Chaetozone setosa*, the CMJ (Carnivore, Motile, Jawed) 12.1%, OMN (Omnivores) 8.3%, and FDT (Filter-feeders, Discretely motile, Tentaculate) which includes only the species *Owenia fusiformis* and still occupies 6.2% of the total trophic group abundance. Groups with the smallest abundance are: FST (Filter-feeders, Sessile, Tentaculate), CMX (Carnivore, Motile, non-Jawed), SMX (Surface, Deposit-feeders, Motile, non-Jawed), BMJ (Burrowers, Motile, Jawed), CDJ (Carnivore, Discretely motile, Jawed) SDJ (Surface, Deposit-feeders, Discretely motile, Jawed) and SST (Surface, Deposit-feeders, Sessile, Tentaculate) which share together 3.5% of the trophic abundance (Fig. 1).

Great quantity of organic substance in Biocoenose of Coastal terrigenous ooze at the sites under the influence of the riverbone silt causes great density of the polychaeta assemblages, especially of the burrowing. In this Biocoenose we distinguish two aspects which differ according to their participation of the mud fraction in the sediment. These distinctions are visible also in respect to the trophic groups which confirm that for the diffusion of the burrowing groups it is not decisive only the quantity of the organic substances in the sediment, but also the size of the sediment particles enabling easier digging.

On the other hand the filter-feeding group is nearly completely absent from this Biocoenose, but it is properly developed only in the Biocoenose of the Coastal detritus bottom together with the omnivores. We isolate from the filter-feeding the *Owenia fusiformis* in which the moderate sedimentation and the silt do not disturb it and create dense population especially in the Biocoenose of the Coastal detritic mixed with ooze. The carnivores group is equally developed in all the three explored Biocoenoses, and probably the concentration of their prey influences mostly their diffusion.

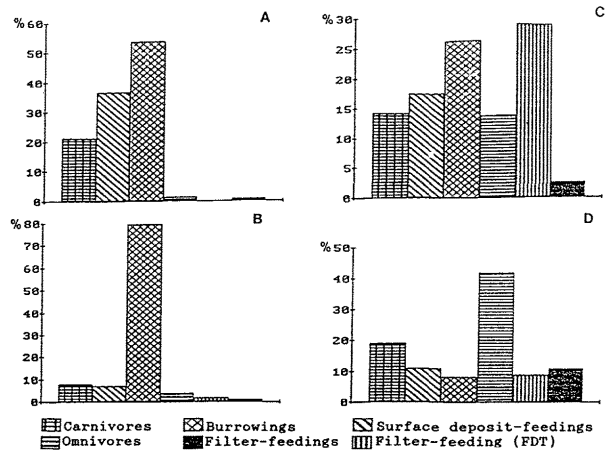

Fig 1. Trophic groups. A: Coastal terrigenous ooze (clayey-silty-sand), B: Coastal terrigenous ooze (silty-clay), C: Coastal detritic with ooze, D: Coastal detritic.

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Inventory of the Rijeka Bay marine flora (North Adriatic)

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The Rijeka Bay marine flora seldom was subject of botanists' interest (VOUK, 1915; BENACCHIO, 1938; LINARDIC, 1949). Basic data on the inventory and distribution of benthic flora in Rijeka Bay were obtained by research carried at the Krk Island in 1976-1978 and 1981 (ZAVODNIK *et al.*, 1981). Additional surveys were performed at the Cres Island, along the eastern coast of the Istrian peninsula, and along the northern coast of Rijeka Bay. It is a relatively close area, encircled to the south and east by Cres and Krk Islands, and to the north and west side by the mountain highlands of Risnjak and Ucka. The coast is rocky and mostly steep, somewhere quite vertical. Only in the Krk Island area the coast is gently sloping. Over the whole Bay, within the compact rocky coast, small gravel beaches are interclated. At gently sloping sites, at the depth of 2-3 meters, the rocky bottoom is substituted by sandy sediments which are often rich in organogenic detritus. The deep bottom plain is characterized by coastal terrigenous ooze. The area close to the Rijeka city is considerably affected by wastes of urban and industrial origin, especially the northern coastal area between the Lovran-Opatija Riviera and Kraljevica townlet, and in particular Bakar Bay.

Our field research and samplings were carried over the whole Rijeka Bay, at 65 transects mostly surveyed by SCUBA divers. The bionomic zones of supralittoral, mediolittoral, infralittoral, and partly circalittoral were studied.

Table I. Taxonomic survey of the Rijeka Bay algal flora

	RHODOPHYTA		PHAEOPHYTA		CHLOROPHYTA		Total
	No.	%	No.	%	No.	%	No.
Species and infra species taxa	188	59	69	21	63	20	320

The analysis of the plant material enabled the accomplishment of a relatively rich inventory of the Rijeka Bay benthic flora. In total 320 taxa (species, subspecies, varieties and forms) were recorded (Table I). Besides these eucariont algae, 9 species Cyanophyta, and 4 marine phanerogams (Angiospermae) were identified.

With an account to the diversity of marine benthic flora studied Rhodophyta absolutely dominated (190 taxa = 58.7 %). The Phaeophyta and Chlorophyta taxa shared in about the same relations i.e. 69 (21.6 %) and 63 (19.7 %) taxa (Table I). The established R/P ratio was 2.7.

Table II. Species numbers and floristic composition of Rijeka Bays algal groups. Distributional elements: AM = Atlantic-Mediterranean, MM = Medit., AMP = Atlantic- Medit. - Pacific, AMI = Atlantic-Medit.-Indian, CT = Circumtropic, AD = endemic Adriatic, CP = Cosmopolitic

	RHODOPHYTA		PHAEOPHYTA		CHLOROPHYTA		Total	
	No.	%	No.	%	No.	%	No.	%
AM	109	58.0	31	44.9	44	69.8	184	57.5
MM	53	28.2	19	27.5	11	17.5	83	25.9
AMP	11	5.9	0	0.0	2	3.2	13	4.1
AMI	5	2.7	2	2.9	0	0.0	7	2.2
CT	2	1.1	5	7.2	0	0.0	7	2.2
AD	1	0.5	6	8.7	1	1.6	8	2.5
CP	7	3.7	6	8.7	5	7.9	18	5.6
Total	188		69		63		320	

By its origin, the Rijeka Bay benthic flora, and generally also the flora of the entire Adriatic Sea is not homogeneous: it comprehends floristic elements from several phytogeographic regions (Table II). With regard to the number of taxa, and percentage portions Atlantic-Mediterranean and typical Mediteranean floristic elements (in total 267 taxa = 83.3 %) are characteristic in the area surveyed. The other five phytogeographic regions contribute to the Rijeka marine algal flora by only 16.7 % of the taxa identified.

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Actual knowledge on the Rijeka Bay benthic fauna (the North Adriatic Sea)

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Although the biological research in the Adriatic Sea is an about four centuries long tradition, reviews on particular animal groups, and regional check-lists of marine fauna are rather scarce.

The only attempt to review the total macrofauna of the Adriatic Sea is that of STOSSICH (1880-1885), followed by CARUS (1885-1893), and in part also that of RIEDL (1963). GRAEFFE (1881-1905) and VATOVA (1928) treated chiefly the Gulf of Triest and the Rovinj area, respectively. The total fauna of other Adriatic regions has never been considered.

Table I.- Species numbers and distributional pattern of the Rijeka Bay benthic fauna

Taxon	Species Nos	Adriatic	Mediterranean	Atlant.-Medit.	Amphiatlantic	Boreal-Medit.	Boreal	Cosmopolite	Others
PORIFERA	43	-	12	6	-	3	1	10	11
CNIDARIA	32	1	9	15	-	2	-	2	3
MOLLUSCA	186	1	35	99	1	44	3	2	1
NEMATODA	35	1	13	4	6	3	1	3	4
ANNELIDA	124	1	6	44	9	29	7	13	15
CRUSTACEA	105	1	22	51	4	12	-	-	15
ECHINODERMATA	45	-	8	24	-	10	-	2	1
VERTEBRATA	101	-	21	63	2	10	-	5	-
VARIA	46	-	6	17	1	4	4	8	6
Total No.	717	5	132	323	23	117	16	45	56
Total %	99	1	18	45	3	16	2	6	8

We have undertaken, therefore, efforts to compile old literature and our recent data on benthic fauna in Rijeka Bay, outstanding by its industrial, traffic and touristic importance in the national economy. The Bay is a semi-closed marine area which surface is 550 km2, and average depth about 60 m (maximum 66 m). It is famous for its peculiar hydrographic properties (DEGOBBIS, 1981) and rich in a variety of benthic habitats. Benthic communities most distributed in the area are littoral communities of rocky shore, the biocoenosis of photophilic seaweeds, and communities of fine well calibrated sands and coastal detritic ooze, respectively. In the northern part of the Bay pollution effects were noted.

Modern studies in the area were introduced by LORENZ (1863) but since then no check-list of benthic fauna has ever been prepared. According to our review, by now, 717 benthic species were noted in the area (Tab. I). The species list reflects the absence, or scarcity of previous research and collection of taxonomic material in some peculiar benthic habitats, such as beach gravels mixed with boulders, algal assemblages, and criptic habitats. Therefore, the data on some high animal taxa are almost completely lacking, especially on Foraminifera, Turbellaria, Copepoda Harpacticoida, and Isopoda. Some other groups, such as Porifera, Hydrozoa, Nemertina, Ostracoda, Tentaculata, Tunicata, and others, obviously deserve the taxonomists' interest in the nearest future. With regard to data available from other Adriatic regions, after thorough taxonomic studies, in Rijeka Bay at least 1500 benthic animal taxa can be expected.

Most of the species listed belong to stocks of the Mediterranean and Atlantic-Mediterranean distributional pattern (Tab. I). Actually, in opposition to old suggestions based on peculiar hydrographic features of the area, taxa of boreal origin are not common. Only four taxa are considered hitherto to be Adriatic endemics (*Epizoanthus univittatus, Cultrensis adriaticus, Astomonema otti, Lumbrinereis rovignensis*) - a qualification which perhaps is more reliable to our present knowledge than to a real distribution of taxa.

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X

Note on the marine flora of the Banjole islet (North Adriatic)

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The small islet Banjole, located at 1 Nm off Rovinj, is wide known as a traditional training area of students in biology from many European universities. The islet is famous for its two underwater caves, excellent communities zonation related to the exposure to wind and waves and richness of habitats. It is strange enough that the islet's marine flora has never been studied in detail. According to previous notes, mostly occasional, of which some were recorded more than a century ago, the Banjole islet is extraordinarily rich in dense brown algae assemblages which distribution reflect influences from coastal and offshore waters.

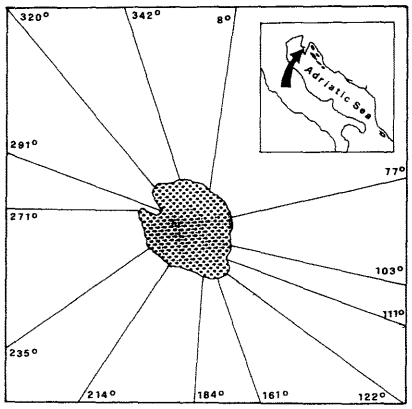

Fig. 1.- Islet Banjole: sampling sites

Some 20 years ago, dense *Cystoseira* and *Sargassum* settlements covered completely the islet's rocky slopes, and on the detritic sandy bottom a *Cymodocea nodosa* meadow was mapped (ZAVODNIK, 1967, SENES, 1988). Around that time already a decrease in algal abundance was noted in the Rovinj city area which was obviously caused by a complex industrial and urban pollution (GOLUBIC, 1968, KATZMANN, 1972, MUNDA, 1974). In the past decennium, basic alterations occurred in the islet's benthic communities, too. In the upper infralittoral zone, algal forests decreased to a stage of a ground carpet, and the *Cymodocea* bed disappeared. Our research performed along 13 SCUBA transects (Fig. 1) revealed only 145 algal taxa: Rhodophyta 98, Phaeophyta 27 and Chlorophyta 20 (Fig. 2).

To day, in the islet's mediolittoral zone in the winter-spring period the mostly common annual species are *Ulva rigida*, some *Enteromorpha*, *Cladophora* and *Ceramium* species.

In the summer period they are substituted by diverse *Gelidium*, *Gelidiella*, *Polysiphonia* species and others. At some sheltered sites low quantities of the perennial brown alga *Fucus virsoides* occurred, while on the exposed rocks a worm-like *Nemalion helminthoides* was noted. The infralittoral habitats are covered by dense settlements of *Padina pavonica* mixed with *Acetabularia cetabulum*. *Cystoseira* species were mostly substituted by *Stypocaulon scoparia* and *Dictyota* species. At the depth of 10-20 m, at a distance of about 30 m from the shore line, dense assemblages of *Pseudolithophyllum expansum* occurred, while *Peyssonnelia polymorpha* and *Peyssonnelia rubra* indicate a typical infracoralligene in the sense of SENES (1988). On calcareous algae were rarely attached solitary thalli of *Cystoseira corniculata* ssp. *laxior*, *Dictyota linearis*, *Codium bursa*, *Halimeda tuna* and *Udotea petiolata*. Changes in the Banjole marine flora, conspicuous to all divers, in all probability were instigated by complex pollution agents.

But recently also several eutrophication phenomena are perhaps involved in the decrease of some algal and seaweed assemblages in the entire area, which remind as the consequences of anoxic conditions on the marine fauna.

Consequently, one can point out the following facts:

1.- In the near past, dense settlements of fucoids and *Cymodocea nodosa* have disappeared in the Banjole islet area.

2.- Perennial fucoid species were mostly substituted by settlements of annual Chlorophyceae, Sphacellariaceae, Dictyotaceae and especially by red algae i.e. Corallinaceae and Gelidiaceae.

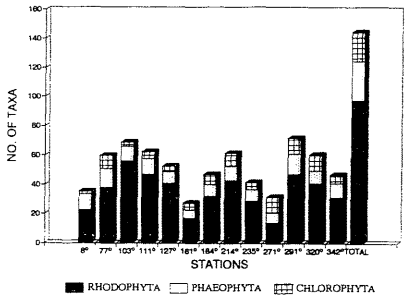

Fig. 2.- Total taxa and number of Rhodophyta, Phaeophyta and Chlorophyta at each study site

3.- The total flora at the thirteen sites studied consisted of 98 taxa pertaining to Rhodophyta, 27 to Phaeophyta and 20 to Chlorophyta. The R/P ratio was 3.6.

4.- It seems that reiterated short-time coverings of organic mucous materials did not have harmful effects to seaweeds as they had to sessile animals at the same habitats.

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A comparison among some suspended matter characteristics in two tidal inlets of the Marano Lagoon (Northern Adriatic Sea)

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Tidal inlets represent the points of exchanges of water and suspended sediment between lagoon basins and open sea. So here it may be easy to define fluxes and evaluate mass balances by means of appropriate surveys. In order to obtain these purposes, one should evaluate the temporal stability of suspended matter concentrations and of mineralogical and grain size characteristics, at the same tidal range conditions, spotting out and valuating the peculiarities of perturbing events.

In an Eulerian approach to the problem, two nearby tidal inlets (Lignano and S. Andrea) have been sampled along water column to verify the changes in concentrations and the different features of suspended matter in a same point of the tidal cycle.

During the central phase of flood and ebb tide, water sampling (with a Niskin-type bottle), and measurements of temperature, salinity and current speed have been carried out twice a day, for seven consecutive days (from the 27th July to 2nd August, 1991). In that period tidal range varied from 115 to 79 cm; maximum current speed was 1.2 m/s at Lignano inlet. For comparison, samples of sea water were also picked up at about 1 km from the coast.

The two lagoon basins and corresponding inlets show different charateristics. The Lignano basin has a surface of about 40 km2, and its inlet is 550 m width and 10 m depth. S. Andrea basin has a surface of 8 km2, the inlet is 350 m width and 7 m deep. This inlet is not periodically dredged.

During sampling time, weather conditions have been constantly monitored by the weather station of Lignano, which is run by the Physics Department of the University of Udine. It must be said that wind average hourly speed has exceeded 5 m/s in the following days: 27th and 31st July.

At Lignano inlet, total suspended matter concentration (TSM), measured gravimetrically using Whatman GF/F filters, shows an increase from surface to bottom. On the other hand, at S. Andrea inlet TSM values are quite uniform in the whole water column (Tab.I). In calm sea conditions and with wind speed lower than 5 m/s, TSM ebb concentrations are always higher than the flood ones (as reported in BRAMBATI *et al.*, 1983). Besides TSM concentrations show quite different values in the two inlets. This is probably due to the different surface, morphology and depth of the two basins, as well as their different behaviour in respect of wind waves. In windy weather conditions, TSM values in and out the inlet are clearly above the mean values of Table 1 (see also BRAMBATI *et al.*, 1990), with some flood concentrations higher than ebb ones.

The carbonates percentages of sea samples are nearly 30 %: in the Lignano inlet the values are uniform and range from 30 to 40 %. In S. Andrea inlet the values are unsteady and they often may exceed 60 %, expecially with rough sea. The higher values (directly correlated with TSM) measured in the S. Andrea inlet are to be related to mainly carbonate sandy shoals in front of the inlet.

	T.S.M.			% carbonate			median diameter				
	S	M	B	S	M	B	S	M	B		
Lignano	3.4	4.2	5.2	30.8	40.1	42.7	11.4	12.8	13.8	mean	
	0.8	1.6	2.2	5.7	6.9	5.8	1.3	2.5	2.9	st.d.	FLOOD
S. Andrea	2.4	2.1	2.3	29.8	34.0	34.6	10.7	11.3	10.3	mean	TIDE
	1.5	0.9	1.2	7.5	6.4	2.5	1.3	2.1	1.5	st.d.	
Lignano	4.3	6.2	7.7	38.7	39.5	39.7	13.3	14.1	15.1	mean	
	0.6	1.3	3.1	1.8	4.3	1.5	1.8	1.7	1.7	st.d.	EBB
S.Andrea	3.1	3.0	3.5	37.4	40.6	44.3	12.0	11.5	12.6	mean	TIDE
	0.7	0.8	1.1	5.4	6.7	10.3	2.2	1.4	2.3	st.d.	
sea	1.6			30.9			10.0			mean	
	0.5			9.1			0.9			st.d	

Table 1.- Mean and standard deviation values of total suspended matter (TSM, mg/dm³), percentages of carbonates, median grain diameter (µm). S= surface; M= mid-detph; B= bottom. Data relative to windy days have been omitted from computation.

In order to determine the grain size, the samples were analyzed with a Coulter Multisizer in the range 2.8-90 µm. Reported values are the average of three analysis. There is a strong relationship between the median diameter and the 5th percentile (coarser). In Lignano inlet samples the median diameter always increases from surface to bottom (from 10 to 18 µm). The lower values, similar to sea-water values, are observed in flood surface water.

In S. Andrea inlet values range from 8 to 16 µm, with values lower than Lignano ones. In water column the trend is irregular: the higher value is often seen in medium depth; the lower value is observed, by turns, in surface or bottom water.

To complete the knowledge of composition of suspended matter, mineralogical analyses and organic C and N measurements have been working on.

Finally the repeatability of sampling w.s confirmed by stability of examined data, with the exception of periods during and immediately after rough sea due to wind waves.

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Allozyme variability in the clam *Ruditapes philippinarum* from two stocks cultivated in different Adriatic Lagoons

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Ruditapes philippinarum is a clam native to Japan, with a wide distribution in the Indopacific area. This species is presently nearly cosmopolitan, as it has been imported into many countries for its better productivity in comparison with native clams. Introduction into the Adriatic dates back to 1983, when it was first cultivated in the lagoon of Venice. Breeding plants are now present in several brackish basins of the Northern Adriatic.

In order to increase the productivity of hatchery stocks, it is very important:

1) to acquire detailed knowledge of the genetic structure of wild and artificial populations,

2) to verify to what extent the genetic architecture of the strains can be modified by natural selection, and

3) to test whether the process of adaptation is similar in different lagoons, and in marine areas.

Moreover, the fact that *Ruditapes philippinarum* is undergoing a rapid phenomenon of naturalization means that it is a good model to study the evolution of the genetic structure of populations during the spreading phase. Comparison with native species, which are probably poorer competitors, may throw some light on the relations existing between the genetic architecture of a species and its performance as competitor and colonizer.

Genetic variability was estimated by the electrophoretic analysis of allozymes. Heterozygosity may be a relevant parameter, as it has frequently been proven to be related with morphometric traits and growth. Besides, heterozygote deficiencies appear to be a common feature in many bivalve species, but the explanation of these findings is still rather unclear.

Samples from cultivated stocks were collected in two brackish basins in the delta of the river Po: the lagoons of Caleri (samples C1 and C2), and Scardovari (S1 and S2). Sampling was repeated in April and September 1991. Electrophoresis was carried out according to BORSA and THIRIOT-QUIEVREUX (1990), testing eight enzyme systems for a total of 15 loci, only one of which (Mdh-2) did not show any variation. The number of animals scored, number of alleles per locus [NA], observed heterozygosity [Ho] and heterozygote deficiencies [(Ho-He)/He] are reported in the table.

As can be seen in the table, the strains have a rather hight level of heterozygosity, similar to that found in previous studies (BORSA and THIRIOT-QUIEVREUX, 1990; MATTOCCIA, 1991). The presence of a good degree of genetic heterogeneity may represent a potential advantage for breeding, as it provides raw material to artificial selection.

Allele frequencies of a number of loci differed in the two basins. In the lagoon of Caleri a difference was found with respect to the estimates obtained from naturalized populations (MATTOCCIA, 1991). These findings suggest the possible involvement of selection and adaptation to local ecological conditions.

		N. INDIVIDUALS				Ho x 1000				(Ho-He)/He x 100			
LOCUS	NA	S1	C1	C2	S2	S1	C1	C2	S2	S1	C1	C2	S2
Aat-1	3	100	87	45	80	230	207	156	275	-8	-8	-39	-1
Aat-2	4	73	86	33	55	370	233	182	273	-3	-17	-53	-16
Pgm-1	3	93	88	56	94	419	432	339	468	-23	-17	-37	-16
Pgm-2	3	/	71	/	59	/	169	/	254	/	-13	/	-41
Pgi-1	6	100	89	60	98	570	742	650	653	-9	+7	-10	+6
Pgi-2	3	100	87	/	20	80	207	/	100	-9	+9	/	-55
Glo	3	89	84	61	98	270	440	262	367	+12	-2	-13	+7
Idh-1	4	89	92	45	98	326	446	289	367	-11	0	-26	-12
Idh-2	3	94	93	--	78	96	237	/	141	-31	-6	/	-33
Lap-1	4	92	86	61	96	359	267	180	281	-28	-25	-50	-23
Lap-2	3	--	67	--	76	/	388	/	553	/	-25	/	+39
Mdh-1	3	80	71	61	100	75	56	66	10	+7	+4	+3	0
Mdh-2	1	80	71	61	100	0	0	0	0	/	/	/	/
Sod-1	4	--	52	56	100	/	135	55	70	/	+7	+4	+3
Sod-2	3	80	86	55	100	137	209	291	150	-21	-10	-3	-6

Our data are in accordance with the common finding of a heterozygote deficiency. As the table shows, the defect is the most frequent condition (35 out of 49 cases), although only six revealed a significant difference. Several hypotheses, reviewed by GAFFNEY *et al.* (1990), have been suggested to explain this phenomenon but, at the present state of research, it is not possible to make a choice. It is probably better to conclude that "The causes of heterozygote-deficiency.....remain obscure" (ZOUROS *et al.*, 1988).

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Hydrological conditions effects on grey mullet fry migration in Lesina Lagoon : First Results

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In the period September 1989-September 1990, a research was carried out to individualize the meteomarine factors influence on fish fry migration in the Lesina Lagoon. A particular fishing net was used, a modified hand lift-net, previously experimented in a similar research at Lake Fusaro (IANNIBELLI *et al.*, 1988, 1989).

The chemical-physical parameters of water were detected with the following instruments: currentmeter Hontsch Instruments and portable oxygen-meter Leeds & Nordrup, both with magnetic recording, thermometer with reading of the first decimal figure, salinometer Atago and portable ph-meter Electromate Beckman with direct reading. All the instruments and capture equipment were positioned at about 200 meters from the seamouth of the lagoon connecting channel.

The captured specimens were taxonomically identified using the analytical keys of PERLMUTTER *et al.* (1957) and FARRUGIO (1977).

For *L. ramada* it is evidenced that the above species in the migration schooling tends to avoid minimum and maximum temperatures and prefers for its displacements an intermediate temperature range (12-13°C) with salinity about 26-27 ppt. Concerning the dissolved oxygen the most numerous groups of specimens are always found when the oxygen value is far beyond the saturation, up to 13.7 mg/l. For the current, *Liza ramada* avoids extreme values in the cases of greater aggregation, preferring the intermediate ones, between 19 and 25 cm/s, while the favourite flow-direction is the outgoing one.

For *Liza aurata*, in the Lesina Lagoon this species tends to aggregate with rather low temperature values (11°C and 7°C). The highest temperature values (over 20°C) keep this species far from the channel mouth and also the lowest values represent a barrier to the displacements: in fact great quantities of *L. aurata* and also *L. ramada* fry were captured only in the sea-tract in front of the mouth, in a whole sampling day (20/1/90). On the contrary, saline preferences in the schooling in migration of *L. aurata* were not evidenced. Both for dissolved oxygen and current velocity *L. aurata* seems to prefer intermediate conditions, between 7.9 and 11.7 mg/l for the oxygen and between 15 and 25 cm/s for the flow velocity, while the favourite direction was above all the outgoing one.

Regarding *Liza saliens* it is present in a range of temperature betweem 57 and 23.5°C and tends to avoid low winter temperatures. It does not seem instead to have any saline preferences, while the data of dissolved oxygen are too scarce to give any useful information. On the contrary, for the ph it is interesting to evidence a clear obstacle to the migration in presence of high values of this parameter (8.6-8.7). Groups of a certain number of specimens of *L. saliens* are captured being present values of current velocity between 16 and 19 cm/s.

Concerning *M. cephalus*, finally, the most numerous groups were captured with water temperatures of 15.7°C and 22.7°C, thus evidencing a certain tendency of this species to avoid aggregation in case of higher temperatures. Regarding the salinity *M. cephalus* seems to move and aggregate without particular preferences, in a range between 28 and 37 ppt. The oxygen data are too scarce to be considered. The ph does not show any particular correlations with the displacements of *M. cephalus* except in only one case recorded, where the high value (8.6) may have created an obstacle to a certain aggregation of animals that were certainly present in the waters in front of Lesina Lagoon. In fact, at the outside of the seamouth quite large quantities of fish fry of this species were captured by means of a circular scoop net fitted with a handle. Regarding the velocity and direction of the current, a clear preference in schooling is to be evidenced in the cases of current velocity of 16-19 cm/s and outgoing flow.

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Presence of some teleosteans species and meteomarine conditions in Lesina Channel Preliminary note

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In the period September, 1989 - September, 1990, a research was carried out aiming at the individuation of the influence of meteomarine factors on the ascent of fish fry in the Lesina Lagoon.

The sampling station was established in the channel of Acquarotta, one of the two communications with the sea, situated northwest of this brackish lagoon (MAROLLA, 1989 L. In the course of this research specimens of different genera were captured, besides those belonging to Mugilidae that have represented most of the captures. Species identification was carried out following TORTONESE (1970, 1975) and RANZI (1933).

In particular, the presence of juvenile stages of *Sparus aurata* L. has been noted. They were captured in a more numerous group (14 specimens) under the following conditions of marine parameters: the water salinity presented the lowest value in the whole measuring campaign (S=22), the temperature was 15°C, for the current (in outgoing flow) values of medium-high velocity were recorded, while the dissolved oxygen was 15.1 mg/l. In another case of capture concerning this species, the salinity was 34 ppt, while the temperature and oxygen values were lower (13°C and 14. 3 mg/l) compared to the preceding case and the flow incoming. For this species, also the few data at disposal can give a rather significant idea of its behaviour while migrating, as the displacements are noted in presence of water showing values of lower salinity and higher temperature. On the contrary, the concentration of dissolved oxygen does not seem to be a determining factor. However, in conditions of over-saturation for the given temperatures, the inversion of the flow direction (outgoing in the first case and incoming in the second), may have had instead a certain influence on the specimens' density in the two groups for the well-known phenomenon of fish stream tropism.

Moreover, the presence of Clupeids was noted and precisely a group of 205 specimens of *Sardina pilchardus* Walb, in hydrological conditions of S=34, T=13°C, ph=8.2, and with values of dissolved oxygen rather elevated (13.6 mg/l) with outgoing flow.

As far as *Atherina boyeri* (Risso) is concerned, this species seems to aggregate and move in conditions of not high salinity (31 high temperature (24.8°C) and medium-low velocity of the current (12 cm/sec) as regards the whole sampling period.

Concerning the two specimens of *Diplodus sargus* (L.) and *Lithognathus mormyrus* (L.) captured, it is not possible to get any information from the few data at disposal. It can be noticed that the above species are found in very similar hydrological conditions, except for the current, in a phase of outgoing flow for both cases, but resulting to be very weak (4 cm/s) for the capture of the *Diplodus*, while on the other hand, quite elevated (41 cm/s) in the case of the *Lithognathus*.

The captured specimens belonging to the families of Gobiidae, Syngnathidae and Blenniidae are still in phase of identification.

Finally, for Mugilidae, besides the fish fry we deal with in a separate study, it is to be noted the presence of a group of adult specimens of *L. saliens*, contemporary with the recording of the highest temperature values of the day (30°C) and with salinity and velocity of the current of 30 and 4 cm/s respectively, in the only case of sampling with incoming flow.

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Les Lagunes Nord-Adriatiques : charnière biogéographique et écologique

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Le district de l'Adriatique septentrionale, dans son ensemble, présente de bien connus caractères qui le distinguent du monde méditerranéen. Le déroulement à Trieste, tout au bout de l'Adriatique, de la 33ème Assemblée Plénière de la CIESM nous semble offrir une occasion pour rappeler et préciser quelques caractéristiques biogéographiques et écologiques de ces particularités, surtout au niveau des grandes lagunes qui bordent la mer.

a) Le "subatlantisme". Une latitude élevée (la plus élevée en Méditerranée); une basse salinité liée à la concentration d'estuaires et de deltas, qui déterminent également une importante concentration d'éléments nutritifs en mer et des ampleurs, exceptionnelles en Méditerranée, des marées - que l'Adriatique du Nord partage, il est vrai, avec le Golfe de Gabès, mais en conditions climatiques et hydrologiques bien différentes - confèrent au paysage nord-adriatique des traits rappelant celui de l'Europe atlantique moyenne. Ces caractères sont soulignés par la faible profondeur de la mer et sa circulation relativement fermée, presque "lagunaire", et par le macroclimat, marqué par une pluviosité élevée et par des hivers froids, frappés par la "bora" et d'autres vents du premier cadran.

b) A ce "subatlantisme", relique probable d'un Pléistocène froid, on peut relier le phénomène flori-faunistique que l'on appelle "lacune nord-adriatique", consistant dans l'absence locale de certaines espèces et de certains groupements de la bionomie méditerranéenne, parfois remplacés par des élements atlantiques ou médio-européens (GIORDANI-SOIKA, 1962).

La "lacune" est soulignée par la présence, unique en Méditerranée d'un *Fucus, F. virsoides* J.Ag., qui de la Dalmatie rejoint Trieste et Venise pour conclure sa distribution dans la petite lagune de Porto Caleri, entre le delta du Pô e l'Adige, probablement parce que, plus au sud, des substrats durs, où il pourrait s'ancrer, font généralement défaut.

c) Ces caractéristiques sont particulièrement évidentes dans les lagunes au Nord du Pô (qui, coulant le long du 45° parallèle, constitue une limite biogéographique importante: SACCHI, 1978), notamment dans les grandes lagunes de Venise et de Grado, sièges depuis des millénaires de centres urbains et d'activités de pêche et d'aquiculture. Le paysage lagunaire montre là de suggestives analogies avec celui des côtes atlantiques par des formations végétales semblables, telles les "barene" intermaréales, analogues au "schorre".

d) Cet ensemble de phénomènes donne aux lagunes nord-adriatiques des traits conservateurs, qu'accentuent des présences uniquement, ou surtout, lagunaires; il s'agit p.e. de *Littorina saxatilis* (Olivi) décrite par Chioggia, très commune dans l'intermaréal atlantique, abondante à Venise en milieu varié (substrats durs et barene), connue pour Grado, mais non de la mer. *L. saxatilis* se retrouve dans le Golfe de Gabès: il s'agit évidemment d'une présence liée à d'importantes marées. Un autre cas intéresse les Diptères halophiles (SACCHI *et al.*, 1989).

e) L'homme a depuis longtemps entretenu et renforcé le caractère conservateur des lagunes nord-adriatiques: en détournant les rivières, il en a ralenti l'enterrement, dont la lagune de Caorle montre aujourd'hui les conséquences, étant réduite à une série de "valli" de pêche et de canaux; d'autre part, défendant les lidos par de puissantes et coûteuses digues ("murazzi") il en a entravé l'abrasion par la mer.

f) Ce n'est pas le seul aspect de l'activité humaine en lagune. L'arrêt et le retard de l'évolution des communautés biotiques vers des niveaux d'équilibre que les actions mécaniques ont provoqués, entraîne un dérangement de ces équilibres, avec la disponibilité de niches écologiques qui, faute d'indigènes, sont actualisées par des élements venus d'ailleurs (SACCHI et OCCHIPINTI, sous presse).

g) Il faut en outre rappeler que, si le milieu lagunaire est très sélectif, par la variabilité et l'imprévisibilité des facteurs qui y jouent, il présente de remarquables avantages écologiques, par la présence d'un trophisme élevé auquel l'homme donne, par ses villes et ses cultures, une contribution directe importante. Ce sont encore des conditions favorables à la colonisation des lagunes par des espèces végétales et animales non autochtones, mais douées d'une valence élevée ou subtile. Certaines de ces espèces euryèces ou spécialistes ont d'ailleurs été introduites par l'homme lui-même, volontairement (aquiculture) ou involontairement (transports passifs par bateau ou avec des produits halieutiques). Parmi les cas de plus en plus nombreux, de naturalisations permanentes ou éphémères on citera, par exemple, le Bryozoaire Chilostome *Tricellaria inopinata* d'HONDT et OCCHIPINTI AMBROGI, nouveau pour la science, envahissant des micromilieux à substrat dur dans la lagune de Venise: c'est probablement un élément d'origine sud-pacifique, puisque des espèces voisines sont connues du "Southern Ocean" australien (OCCHIPINTI AMBROGI, 1991).

On ne peut, sur ces bases, que douter du caractère "autonome" des biocénoses lagunaires nord-adriatiques. A une vision schématique de ces peuplements s'oppose une conception dynamique, qui en souligne plutôt la fonction de charnière évolutive, entre environnements biogéographiquement et écologiquement différents, tant d'aujourd'hui que du passé.

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X

Ecological continuum along a strong estuarine gradient within the Lagoon of Venice

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Strong environmental gradients often allow to distinguish associations of species which have similar ecological needs. However, these groups are far from being rigidly separated one another. Really, in this case the concept of association is essentially a statistic concept, concerning the frequence and the abundance of single species in sampling stations.

The lagoon of Venice proposes to ecologists a varied choice of environmental gradients, both natural and mainly induced by man. Among natural gradients in aquatic biotopes, perhaps the strongest one is linked to the salinity changes that occur crossing from freshwater to the sea. In the northern Venetian lagoon we can find one of the best estuarine gradients of the Mediterranean area, into which salinity gradually changes from nearly 0 to 33-34‰ along the lagoon bed of the river Dese (14 km length).

The concomitance of both an extended gradient and a comparatively high amplitude (about lm) of the tide also allows a partial analogysm with oceanic estuaries. Our previous papers have already discussed the zonation of ecological groups in relation to the salinity gradient, for both the sessile and scarcely mobile macrobenthos of hard substrata (SCONFIETTI R. & MARINO R., 1989, in *Topics in marine biology*, Ros J.D. (Ed.), *Scient. Mar.*, 53 (2-3): 655-661; SCONFIETTI R., 1991 (1989), *Riv. Idrobiol.*, 28, 1-2: 3-31).

Despite the exasperate essays, sometimes affecting ecological researches, of direct synthesis without the indispensable step of the analytical approach, here we point out the preminent importance of the species approach.

For Peracarids, that have largely showed their role as ecological markers (SCONFIETTI R., *Atti X Conv. Gruppo Ecol. Base "Gadio"*, Padova 1990, in press), the "common lagoon" species slake their distributions within the middle sector of the estuary, sometimes having a typical bell-shaped abundance (fig. 1). On the contrary, the "open lagoon" group includes species that are not specific lagoon elements, but extend their distribution towards the marine pole. Parallelly, some of the "true estuarine" species go up deeply towards the freshwater pole; for the tanaid *Heterotanais oerstedi*, some populations are known stable in rivers.

However, the partition of these 18 species, chosen as characteristics among a total pool of 40 species, into three ecological groups is mainly the result of statistical technics. As a matter of fact, the supposed originality of the lagoon communities may be observed here onlyfor the true estuarine group, that owes its own identity to the close relation with a strong influence by rivers, being strictly confined to the upper reaches. For the remaining groups the separation is only operative. They are constituted by elements whose distributions shade one into another along a clear ecological continuum. Their species belong to a one stock of marine provenance and probably link their ecological differences to different degrees of opportunism, that may cause the blooming of some populations not at their physiological, but their ecological optimum, in relation to the decrease of the interspecific competition (i.e. *Sphaeroma serratum*, SCONFIETTI R. & SOFFIANTINI R., 1988, *Rapp. Comm. int. Mer Médit.*, 31 (2): 59).

Therefore, the group of the so-called "lagoon species" is really a banal marine group deprived, through an ecological grid with more and more close mesh, of the more stenoecious elements, needing both high efficiency of seawater exchange and nearly stable values of salinity.

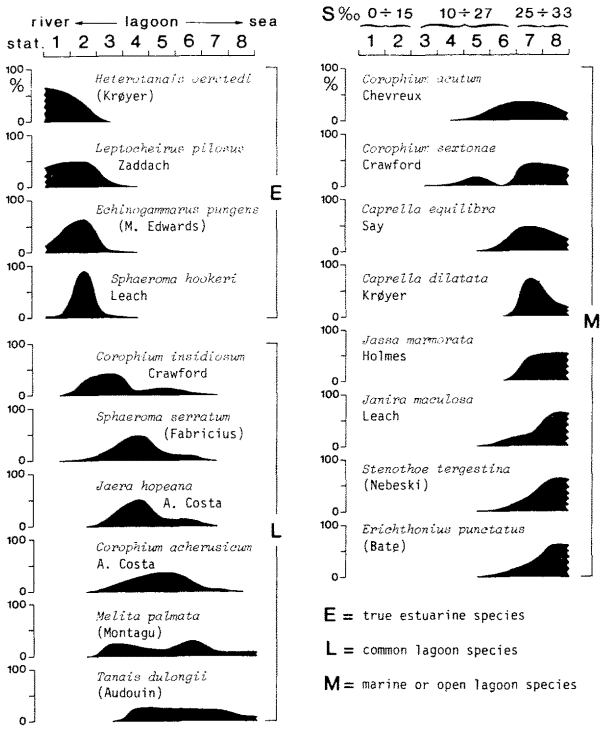

Fig. 1.- Zonation of the most frequent Peracarids along the lagoon course of the river Dese (lagoon of Venice). The salinity range from low to high water values.

Eutrophication and dystrophy in a coastal lagoon (Sacca di Goro, Po River Delta): role of macroalgae, organic detritus and sediment in nutrient cycling and oxygen budget

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The Po River Delta forms a number of naturally eutrophic embayments, where in recent years, increasingly serious summer dystrophic events have been occurring. Dystrophy appears to depend mainly on decomposition of large biomass of macroalgae, which in the last few years have had remarkable development in these embayments as well as in other coastal lagoons of the Northern Adriatic Sea.

This paper summarizes the main results of investigations carried out from 1989 to 1991 on some aspects of nitrogen and phosphorus cycles in the Sacca di Goro, a large eutrophic subtidal lagoon located in the southern part of the Po Delta. Three main goals were pursued:

1.- determination of hydrological and hydrochemical parameters;

2.- analysis of the seasonal succession of macroalgae and studies on production and respiration of both macroalgae and plankton community;

3.- determination of sediment oxygen demand, water-sediment nitrate reduction, and regeneration of ammonium and soluble reactive phosphorus from sediment cores.

The Sacca di Goro has an area of about 26 Km2 and an average depth of 1.5 m. The bottom is flat and the sediment is composed of typical alluvial mud with a high clay and silt content in the northern and central zones. Sand is more abundant near the southern shore-line, while sandy-mud prevails in the eastern area.

In the western and central areas a planktonic grazing-controlled food chain tends to prevail, but, on the whole, the seasonal evolution of the lagoon trophic state depends primarily upon presence and succession of the benthic nitrophilous macroalgae *Ulva rigida* and *Gracilaria verrucosa*.

Seasonal variations of nutrient concentration have shown marked potentially N-limiting conditions, chiefly during spring, and summer. Dissolved inorganic nitrogen (DIN) has shown wide seasonal fluctuations with high winter concentrations and extended summer depletion. DIN concentrations have been also found to be closely related to the nitrogen content in the *Ulva* thalli.

This situation seems to favour metabolic pathways that lead the system to conditions in which nitrogen-limitation plays an increasingly important role because of the appearance of nitrogen-accumulating algae (HOWARTH, 1988). In fact, *Ulva* and *Gracilaria* seem to be able to store available nitrogen and use it to support their growth when DIN depletes (FUJITA *et al.*, 1989). Competition for DIN seems to be the main mechanism causing phytoplankton depression, since macroalgae show high affinity for nitrogen. Furthermore, shallowness of water and the high amounts of organic matter determine time-space alternation of anaerobic and aerobic conditions due to intense primary production and decomposition processes and turbulence induced by wind or tide currents. Fluctuations in redox conditions appear to favour nitrogen transformation and loss through sequential nitrification-denitrification processes. This seems to contribute to summer nitrogen depletion, enhancing the role of nitrogen as limiting factor.

Oxygen budget data evidence a spring period characterized by oxygen overproduction due to the macroalgal growth. During the summer oxygen consumption prevails causing an accentuated deficit and a widespread anoxic crisis.

The spring phase of massive accumulation of organic detritus followed by a rapid phase involving decomposition and release of inorganic nutrients determines the breakdown of nutrient cycles. Under these conditions the cycling of materials is controlled by an extremely shortened trophic network comprising macroalgae and the associated microbiota.

The processes taking place in the top sediment layer play a central role. On one hand there is a notable release of inorganic nutrients (ammonium nitrogen, orthophosphate phosphorus). Yet, anaerobic microbial processes become more significant, bringing about considerable nitrate losses due to nitrate reduction and denitrification.

The system migth be described with good approximation by a model including a spring phase dominated by assimilation processes, and a summer phase dominated by decomposition, dissimilation and nutrient release.

The succession of such phases tends to strengthen the importance of nitrogen as a limiting factor and the metabolic role of nitrophilous algal communities and the microbial loop associated with them. This dynamics could constitute a self-enhancing loop for the system.

Consequently the lagoon becomes increasingly more unstable and episodes of collapse of its trophic equilibrium could become increasingly harsh.

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X

Investigation on Dissolved and Suspended Heavy Metals of the Dese River (Venice Lagoon)

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Rivers and channels of the Venice Lagoon drainage basin collect heavy metals from industrial, agricultural and municipal sources. They successively discharge in the lagoon in correspondence of the estuarine shallow-water areas, where both water chemical-physical behaviour and circulation are often quite difficult to evaluate because of the presence of numerous tidal channels and the complexity of the morphology.

Starting from a general investigation on the yearly pollutant load variations of the eight main tributaries (BERNARDI *et al.*, 1986), a representative test-area for the study of the behaviour of discharged heavy metals was chosen in correspondence of the estuarine system of the Cona Marsh (BERNARDI *et al.*, 1988). This marsh (Fig.1) is directly interested by the Dese River and for its hydrodynamical and water chemical-physical characteristics - is one of the more complex sub-areas in the Venice Lagoon.

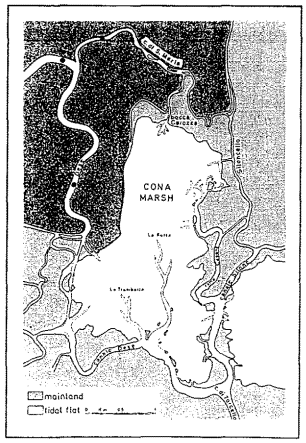

Fig .1 Map of the Cona Marsh.

During the last five years, field measurements were done to evaluate and study the extent and behaviour of water pollution in the marsh. Numerous samples were collected and analyzed for their heavy metals content by P.I.X.E. This multielemental technique (CECCHI *et al.*, 1987) permits to analyse both particulate and dissolved metals through the preparation of suitable thin "targets" from the samples and their exposition to 1.8 MeV proton beam.

Because of the key-role of suspended particles (with diameter up to about 8 microns) in both transport and accumulation in the sediment of this area (GHERMANDI *et al.*, 1991; ZONTA *et al.*, (a) will be published), the filtration through the usual 0.4 microns pore size filter is not adequately descriptive for this kind of study and often produces filtered samples with a very low concentration of some heavy metals. Therefore, aliquotes of sample are submitted to two filtration steps (polycarbonate 8 and 0.4 microns membranes) and are analyzed both in the sampling state and after each separation. To improve the maintainance of the filter nominal pore size and to reduce filtration time avoiding the clogging, a filtration system was realized, tested (ZONTA *et al.*, (b) will be published) and patented.

On April 1991 an intense sampling scheme was followed, collecting at different depths water samples in three stations (indicated in Fig.1), following the tidal excursion. Samples were filtered twice as aformentioned and the water behaviour was observed during the sampling. Results obtained are presented, showing the occurrence of scavenging, flocculation and resuspension processes. Some insight on the role of water circulation in the marsh are proposed and underlined the need for future research activities.

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A Study on the *Chironomus salinarius* Population in the Sediment of the Venice Lagoon and during the Emergence Period

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The morphology of the Venice Lagoon is characterized by a complex network of channels starting from the three inlets which permit the tidal water exchange with the Adriatic Sea, and delimiting shallow water areas (like marshes and mud-flats) with mean depth of about 50 cm. Due to the continual discharge of pollutants from point sources and the drainage basin, stressed environmental conditions may be established in the shallow-water areas where the hydrodynamics slacks, with harmful effects as intense macroalgae growth, anoxic crisis and reduction of the water quality. This situation favours the establishment in the sediment of a few tolerant species to the detriment of others more sensible to the environmental conditions, so reducing the variety of the benthic fauna.

For this reason, during recent years the population of *Chironomus salinarius* (Kieffer) has strongly increased in the sediment of the Venice Lagoon. A particular type of hemoglobin in the hemolymph - with high affinity to oxygen (NOCENTINI, 1985) - renders the larvae resistant to anaerobic conditions and therefore their presence in the sediment is an indicator of low environmental quality. This demographic explosion produces considerable trouble to human activities and health (MARCER *et al.*, 1990) and problems for traffic and touring (CERETTI *et al.*, 1985) during the summer period, when numerous chironomid adults fly.

The environmental division of the Italian National Research Council, in Venice, in collaboration with the Ecology Department of the municipal government started a study on the *Chironomus* behaviour to program interventions to delimit and control the phenomena in their growth stage and from spreading. The research activity carried out in the three test areas (Fig.1) during the 1991 is presented and it regards the two principal stages (larval and adult emergence) of the *Chironomus* biological cycle.

The larval spatial distribution was determined in the densely populated area A (CERETTI *et al.*, 1985). The significance of the number of larvae counted in sites corresponding to the vertex of a 500 meter-wide grid and the causes of sampling errors were evaluated by counting larvae in 44 sediment samples (ZAGO *et al.*, 1991 a). The second test-area B is subjected to an intense macroalgae growth (*Ulva rigida*) and it was previously studied to determine water circulation, grain-size and redox characteristics of the sediment and heavy metals accumulation (ZONTA *et al.*, 1990). The research was aimed to investigate the relationship between population distribution and sediment characteristics, showing that finer particles constitute a preferential habitat for larvae (ZAGO *et al.*, 1991 a). Further, Scanning Electron Microscopy (SEM) permitted to photograph both external and internal morphology of the *Chironomus* larva (AVIGNONE *et al.*, 1991), also showing the presence in the intestinal apparatus of ingested fine-grained particles and micro-organisms constituting the diet of the larval stage.

Finally, the Chironomid emergences were observed in the test-area C, close to urban centres to which adults are attracted by the lights. During the summer period, samples of flying adults were collected in the evening hours, providing information on both the daily and seasonal trend and density of emergences and showing population peaks over a five-day cycle, that may correspond to a strategy increasing the probability of reproduction (ZAGO *et al.*, 1991 b).

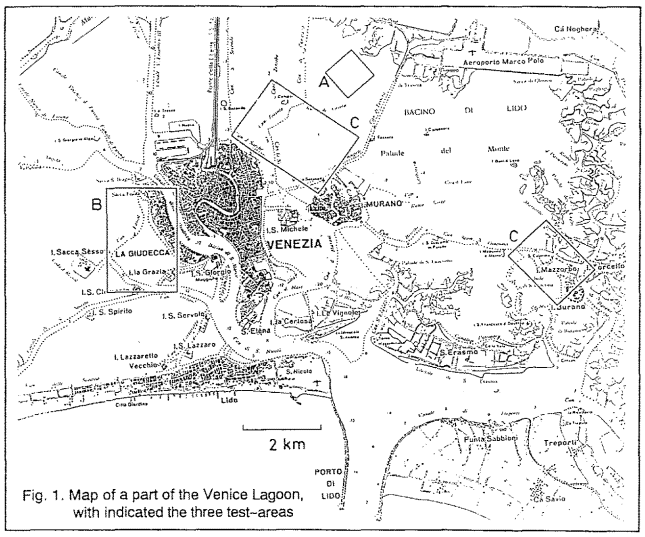

Fig. 1. Map of a part of the Venice Lagoon, with indicated the three test-areas

Authors thank G. MAGRIS (ISDGM-CNR, Venice) for his contribution in sampling and treatment of sediment samples.

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X

Occurence of enteroviruses in the West-Istrian Coastal Area of the Northern Adriactic, Croatia

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Viral contamination of seawater occurs mainly through discharges of sewage effluents into rivers that ultimately find their way to the sea, or through offshore disposal of sewage outfalls.

A control of the presence of viruses in seawater, mussels and sediments collected in the Limski Kanal (mariculture area) and in the touristic centers along the west-istrian coast was performed during the 1989-1990 period. Simultaneously, a sanitary quality control of recreational and mariculture waters as well as mussels was conducted. The concentration of viruses in seawater was done by adsorption in the quartz sand (SCHWARTZBROD and LUCENA, 1978). The elution of viruses from sediment particles was done according to GERBA *et al.* (1977). The minced mussel meat was centrifuged in a buffered solution, followed by a supernatant inoculation on GMK cell line and precipitate reconcentration for hepatitis A virus antigen detection. The enteroviruses level was determined by plaque-assay using GMK cell line (LENETTE and SCHMIDT, 1979). Hepatitis A virus was detected by immune enzyme test (ELISA). The sanitary quality of waters and mussels was assessed according to WHO/UNEP (1977) guidelines.

In water samples only the hepatitis A virus was detected. Meanwhile, in controlled mussels several types of viruses were found (Hepatitis A virus, Coxsackievirus B3, Echovirus types 4 and 11). The following viruses appeared in the sediments: Hepatitis A virus, Coxsackievirus types B2 and B3 and Poliovirus type 3.

Concerning the proportion of virus positive samples (Table 1) waters and sediments from recreational areas were more polluted compared to Limski Kanal area. Meanwhile, a higher viral contamination of mussels was recorded in Limski Kanal area compared to recreational coastal waters.

Table 1. Occurrence of enteroviruses in different matrices.

Study area	Sea water N	(+)	%	Sediments N	(+)	%	Mussels N	(+)	%
Limski Kanal area	27	4	14.8	17	6	35.3	19	6	31.6
Coastal recreational areas	23	7	30.4	33	15	45.5	40	11	27.5

N - number of tested samples, (+) - number of virus-positive samples

Concerning the seasonal aspect of viral contamination the highest number of virus' positive samples was recorded in the mariculture area (35.7 %) as well as in recreational areas (58.3 %) during springtime (Table 2). Due to the karstic type of the Istrian Peninsula and rainy winter-spring period an increased number of virus positive samples during the springtime is expected. The fall increase of viral contamination in recreational areas probably resulted from quadruple effluents enlargement of the touristic centers during the summer-fall period. Most touristic and municipal centers along the coast dispose their domestic wastewaters by traditional methods, which are quite inadequate to destroy viruses. Viruses survive in the marine environment for a prolonged time, especially if protected by particulate organic matter.

Table 2. Enteroviruses occurrence during the seasons of the 1989-1990 period.

Study area	Spring N	(+)	%	Summer N	(+)	%	Fall N	(+)	%	Winter N	(+)	%
Limski Kanal area	28	10	35.7	22	4	18.2	6	1	16.7	7	1	14.3
Coastal recreational areas	12	7	58.3	66	20	30.3	18	6	33.3	-	-	-

N - number of tested samples, (+) - number of virus-positive samples

The most frequent virus detected in water samples was the hepatitis A virus, particularly in Limski Kanal area. Due to the influence of polluted groundwaters from the nearby springs,periodically the internal part of this area did not meet adequate sanitary quality of water and shellfish (FUKS and DEVESCOVI, 1989). A simultaneous sanitary ambient quality control and virus presence detection revealed, that although the water sanitary quality was acceptable according to WHO standards (1983), viruses were detected in the water, mussels and sediments, respectively. The inevitable conclusion, based on an initial screening for detection of enteroviruses, particularly in Limski Kanal, is that the mariculture area is surrounded by potential sources of viral contamination. Undoubtedly, the present finding on the Kanal's utilization for shellfish and fish raising purposes should cause an alarm among all interested and responsible for preventing its contamination. Consequently, water and food sanitary surveillance, besides the present bacterial control, become inadequate. The introduction of virological tests should be considered, especially in cases where the present knowledge indicates that they are indispensable.

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X

Microbiological investigation of the surface water of the Laguna Veneta (North Italy) in relation to light gas-oil biodegradation

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Pollution by hydrocarbons is a serious problem in the Laguna Veneta (North East Italy) because one of the busiest oil port in Italy is located in this area; also, the lagoon receives polluted waters from an heavily industrialized and populated hinterland (FOSSATO, 1990).

Microbial degradation of hydrocarbons, universally recognized as a natural remediation, is the most important biological mechanism in oil decontamination of marine waters.

The aim of this study has been: 1) to assess the distribution of oil-degrading microorganisms in the lagoon; 2) to evaluate the oil degradative potential of surface waters; 3) to isolate strains with efficient oil degradative activity and 4) to test the hydrocarbon-degrading activity of axenic cultures in laboratory condition.

Surface waters from three different stations from the central area of the lagoon (A,B,C, from outer to inner part) were sampled aseptically in November 1990 and in June 1991 with a Schomaker sampler.

Basic physical and chemical parameters were determined in each station and in each period.

Enumeration of total aerobic heterotrophic bacteria was carried out by direct epifluorescence method (HOBBIE *et al.*, 1977). Oil degrading bacteria were determined by the MPN technique (MILLS *et al.*, 1978) and by the Spread Plate Technique. To isolate oil degrading strains, colonies which were different for colour, size and morphology were streaked twice and stored at -80°C in 25 % glycerol.

The microbial activity was determined by oxygen consumption in presence of hydrocarbons. Water samples from each station with and without 0.2 % of light gas-oil were incubated at 22°C. Oxygen consumption was determined by Winkler's method after 7 and 14 days in November 1990, and after 5, 10 and 15 days in June 1991.

To determine the oil degrading activity, at each station 8 flasks with 200 ml of water were spiked with 0.2 % of light gas-oil. Four flasks were sterilized before this addition. The percentage of oil consumed after 5, 10, 15 and 30 days of incubation at 22°C was determined by FIP gas chromatography, after extraction with n-hexane.

To test the oil degrading activity of axenic cultures, the strains best growing on plates were cultured in flasks until stationary phase, then the consumption of gasoil was determined by gas chromatography. The microbial activity was also tested by oxygen consumption measured by Clark's probe.

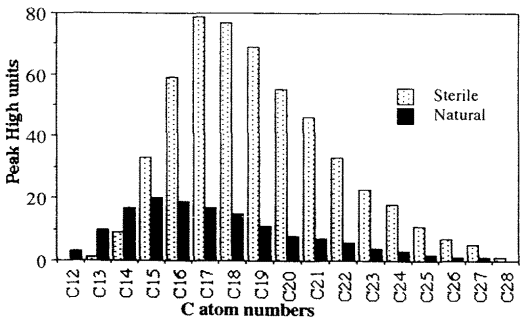
The concentration of heterotrophic and oil degrading bacteria was higher in June than in November. A higher percentage of oil degrading bacteria has been also found in June, probably due to better temperature conditions (ATLAS and BARTHA, 1972). GALASSI and CANZONIER (1977) also found a higher hydrocarbon degrading activity in the Southern part of the Laguna Veneta in warmer season.

The percentage of oil degrading bacteria, considered as a biological index of hydrocarbon pollution (WALKER and COLWELL, 1976) was not significantly correlated with the expected pollution gradient from station A to station C. The threshold of hydrocarbon concentration for induction of oil-degrading activity in bacteria has not been well investigated and no significant correlation has been often found in the environment between the two parameters (LEAHY and COLWELL, 1990).

The oxygen consumption in water samples spiked with light gas-oil was significantly enhanced in all samples, with the highest oxygen depletion in surface water of the station C (June 1991).

The highest oil degradation activity was also found in the same station after 30 days of incubation, resulting in more than 80 % depletion of the n-paraffins (Fig.1).

Fig.1 Degradation pattern of the n-paraffins, determined by gas chromatography, in natural and sterile water samples from the Laguna Veneta after 30 days of incubation at 22°C.



In total, sixty three strains of bacteria were able to grow in presence of oil, the number of isolates being higher in June and mainly in the station C. The strains were mostly gram-negative.

Among the four strains (B1, B4, C3, C4) tested for *in-vitro* light gas-oil degradation, the best hydrocarbon degrading activity has resulted in a depletion of 44.6 % of the gas-oil n-paraffins, i.e. in a consumption of 0.77 µg/mg protein/ml and 5.5 µl O_2/10^9 cells/h by strain C3.

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Bacterioplankton production and its relation to phytoplankton production

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The relation between bacterioplankton production and phytoplankton production was studied on monthly basis from January 1980 to September 1982 in the area of the coastal (Kastela Bay) and open (Stoncica) Middle Adriatic.

Bacterioplankton production constitutes a significant percentage of primary production values in both study areas (Table 1). This means that, apart from primary phytoplankton production, bacteria play an important part in carbon supply to the study areas.

Bacterioplankton production constitutes, on the average, 9 to 28% of phytoplankton production in the Kastela Bay upper layers, and from 10 to 40% in the open sea.

Bacterioplankton appears to play a more important part in organic carbon environmental supply in the open sea, an oligotrophic area, than in the Kastela Bay where other members of food chain occur in greater numbers.

However, it should be emphasized that on some occasions bacterioplankton production may exceed phytoplankton production. This occurs during maximum bacterioplankton activity and termination of phytoplankton bloom (summer) and very often in deeper layers (Table 1) where primary production is minimum due to poor light penetration This was established only for a shorter period of time (in the Kastela Bay in July and at Stoncica in August), whereas annual values for phytoplankton production were considerably higher.

Bacterioplankton production maxima were recorded from both study areas mainly in summer, and those of phytoplankton in spring. This means that there is a time shift in their succession. This shift is more regular in the open sea than in the changed natural environment of the Kastela Bay.

Table 1.- Bacterioplankton production and its relation to phytoplankton (%) (means for 1980-1982 period)

Month	Depth	K.B.	St.	Month	Depth	K.B.	St.
	0	12.4	35.6		0	89.8	99.0
	10	21.7	17.3		10	98.4	<100.0
I	20	12.8	27.5	VII	20	>100.0	>100.0
	30	74.9	49.0		30	>100.0	>100.0
	50		33.9		50		>100.0
	75		49.5		75		>100.0
	0	8.3	25.6		0	82.6	>100.0
	10	4.3	12.4		10	>100.0	>100.0
II	20	6.7	40.3	VIII	20	>100.0	>100.0
	30	60.6	47.3		30	>100.0	>100.0
	50		33.9		50		>100.0
	75		>100.0		75		>100.0
	0	21.2	27.9		0	32.5	76.7
	10	9.0	26.6		10	25.5	73.4
III	20	17.7	15.8	IX	20	98.9	79.9
	30	39.4	36.2		30	>100.0	97.0
	50		45.4		50		>100.0
	75		>100.0		75		>100.0
	0	6.4	6.5		0		75.5
	10	11.5	28.1		10		73.4
IV	20	52.8	21.7	X	20		>100.0
	30	40.5	57.7		30		>100.0
	50		49.8		50		>100.0
	75		>100.0		75		>100.0
	0	8.3	21.7		0	6.7	22.6
	10	99.0	46.6		10	72.3	17.8
V	20	67.5	35.6	XI	20	>100.0	16.7
	30	>100.0	19.2		30	>100.0	42.6
	50		25.1		50		83.7
	75		>100.0		75		>100.0
	0	12.2	41.1		0	-	0.0
	10	15.2	34.4		10	9.7	20.5
VI	20	36.5	48.7	XII	20	>100.0	41.0
	30	69.8	42.5		30	>100.0	27.7
	50		33.1		50		36.2
	75		>100.0		75		>100.0

Light microscope histochemistry of Diatoms in the Gulf of Trieste (North Adriatic Sea)

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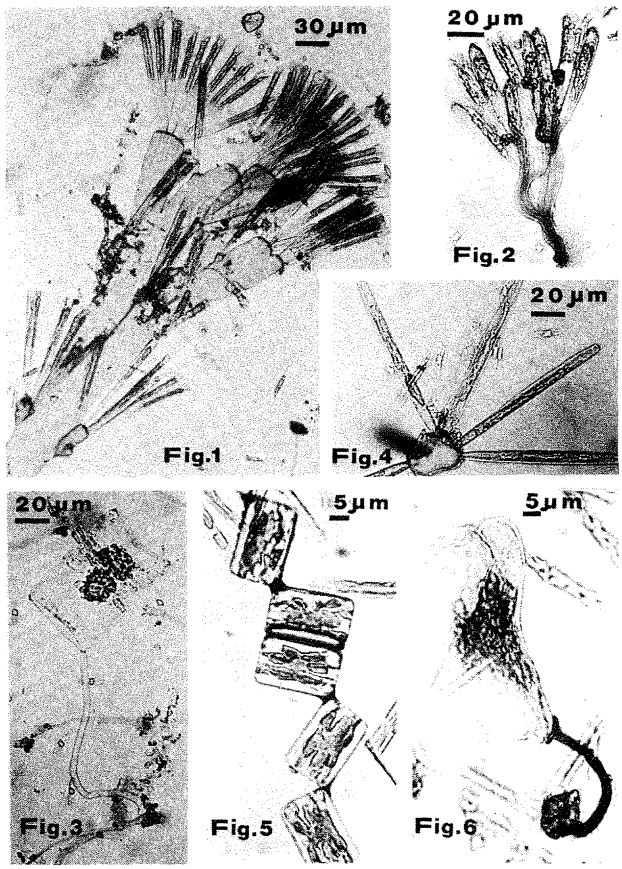
Benthic Diatoms are able to attach to surfaces whether natural (different grain-size sediment) or artificial (glass, ceramic, PVC, etc.). For this reason they are one of the component of the fouling. Attachment is invariably associated with the extracellular secretion of mucilagineous substances which may either remain a simple layer interposed between the Diatom and its substrate, or, through continued secretion, develop into morphologically distinct structures (DANIEL *et al.*, 1987). These morphological structures in unialgal cultures were differentiated by means of several cytochemical reactions (DANIEL, 1983; DANIEL *et al.*, 1987). The aim of this work is to investigate the polysaccharidic component of fouling Diatoms in their natural environment.

Twenty microscope slides fixed on a PVC support were dipped (lm. beneath the surface) in a station localized near the Marine Biology Laboratory (Trieste) in the winter of 1990. These slides were collected and then fixed for 24 h in a 4% (v/v) acid formaldehyde solution in filtered sea water. Ten slides were afterwards stained with Alcian Blue at 2.5 pH (BARKA & ANDERSON, 1963), while the remaining ten slides were stained with Ruthenium Red (BLANQUET, 1976). All light microscope observations were conducted using a Leitz diaplan microscope equipped with a Wild Photoautomat camera using Kodak Ektachrome films.

Using these cytochemical tests we have examined in detail some attachment systems. The stalk of both the *Licmophora* species (Fig. 1, 2) examined comprise polysaccharides of anionic reaction. The stalk is flat and with many branches which yield colonies. *Licmophora flabellata* (Carm.) Ag. (Fig. 1) stalk shows longitudinal striations which correspond to the fused secretions of the individual cells. The stalk of *Striatella unipunctata* Lyngb. (Fig. 3) is weakly stained for anionic polysaccharides. Well developed is the basal and unipolar pad of *Synedra* sp. (Fig. 4) showing intense reaction after Alcian Blue staining. The intercellular adhesive pads of *Grammatophora* sp. (Fig. 5) are also stained with Ruthenium Red and appear as a strong purple spot. Furthermore the subfrustular layer appears like an area weakly stained. *Achnanthes longipes* Ag. (Fig. 6) species shows a stalk with a characteristic collar at basal cell pole and intense staining with Ruthenium Red.



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X

Observations sur le phytoplancton de l'Adriatique du Nord en présence de Macroagrégats mucilagineux (Août 1991)

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Depuis de nombreuses années, on connaît en Adriatique un phénomène qui est dénommé "mare sporco" et qui remonte à 1729. Depuis lors, ce phénomène a été observé plusieurs fois au cours du temps (FONDA UMANI *et al.*, 1989), pour enfin aboutir aux épisodes des années 1988-1991. Même s'il n'y a pas encore de données sûres sur sa formation et sur son origine, les recherches conduites en 1990 et en 1991 nous ont permis, en accord avec d'autres auteurs (HERNDL, 1988; STACHOWITSCH *et al.*, 1990), de formuler des hypothèses différentes de celles proposées jusqu'à présent. Les résultats que nous présentons et qui tiennent compte aussi bien des organismes phytoplanctoniques libres que de ceux associés aux macroagrégats ont été obtenus lors d'une croisière océanographique effectuée pendant le mois d'Août 1991, où la présence des agrégats mucilagineux a montré une intensité semblable à celle signalée en 1988.

Dans dix stations de prélèvement (Fig. 1) on a récolté tous les cinq mètres, de la surface jusqu' au fond, des échantillons d'eau pour l'analyse du phytoplancton et des échantillons de macroagrégats. Le phytoplancton a été analysé séparément en trois différentes fractions: le microplancton (< 200 µm) avec la technique classique de Utermöhl sur des échantillons fixés par la formaldéhyde (5%), le nanoplancton (< 20 µm) et le picoplancton (< 2 µm) à l'aide d'un cytofluorimètre à flux ACR-1500 sur des échantillons fixés par la glutaraldéhyde (1%) et conservés à - 80 °C (VAULOT *et al.*, 1989). Les échantillons de macroagrégats ont été observés aussi bien au microscope à fluorescence qu'au microscope électronique à balayage .

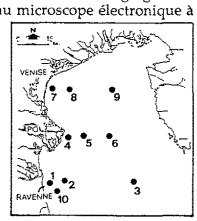

Fig. 1: Mer Adriatique du Nord (stations).

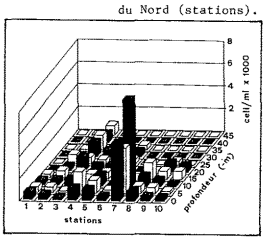

Fig. 2: Densité du microplancton.

Les densités en microplancton sont assez basses (1-200 cell/ml), exception faite pour la station 7 (Fig.2). En tout cas, ces densités sont liées surtout aux diatomées et en particulier à *Nitzschia* cf. *seriata* CL., qui est l'espèce la plus fréquente (70-90 % du total de toutes les stations examinées). Les quantités de nanoplancton varient de 100 à 2000 cell/ml et sont à la charge surtout des petits flagellés. L'analyse au cytofluorimètre a permis d'établir, d'après le contenu en phycobiliprotéine, qu'il s'agissait de Cryptophycées (SCARABEL et ANDREOLI, 1991). Au contraire, les densités en picoplancton sont très élevées (600-40.000 cell/ml) et elles sont dues aux organismes aussi bien eucaryotes que procaryotes (cfr. *Synechococcus*) (Fig. 3).

Les observations au M.E.B. des macroagrégats nous ont permis de remarquer, en accord avec REVELANTE et GILMARTIN (1990) et avec RIEBESELL (1991), que l'abondance et la typologie des organismes microplanctoniques dans ces formations sont tout à fait différentes de celles observées dans les populations des eaux voisines. Comme on peut le voir sur la figure 4, la diatomée la plus abondante est *Cyclotella bodanica* EULENST., qui, du reste, n'a jamais dépassé 40 cell/ml. En outre, on remarque que les organismes les plus fréquents dans les macroagrégats présentent une forme sphéroïdale (Fig. 4: flèches) et sont très petits (< 2 µm). Leur contenu en chlorophylle *a* et en phycobili-protéine permet de les classer parmi les cyano- bactéries picoplanctoniques qui, au contraire de *Cyclotella bodanica*, sont assez abondantes dans les échantillons d'eau. Le petit nombre de diatomées trouvées dans les macroagrégats, comme d'ailleurs d'autres Auteurs l'ont signalé (KIORBOE *et al.*, 1990; STACHOWITSCH *et al.*, 1990), démontrerait une influence prédominante du picoplancton sur la formation de ces macroagrégats. Ceci est en accord avec KIORBOE *et al.* (1990) qui ont mis en évidence que les organismes très petits, inférieurs à 2 µm, et les flagellés sont les plus indiqués pour l'agrégation.

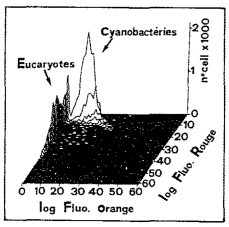

Fig. 3: Cytogramme d'un échantillon de 500 µl de la fraction picoplanctonique.

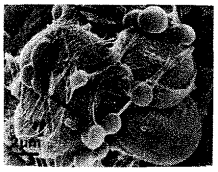

Fig. 4: Agrégats au M.E.B.

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Carybdea marsupialis L. (Cnidaria, Cubozoa) - First observations on its recent massive presence in the mid-northern Adriatic Sea

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The jellyfish *Carybdea marsupialis* L., 1758, with tropical and subtropical distribution (HAECKEL, 1879; HYMAN, 1940; TREGOUBOFF and ROSE, 1957), was first observed in the Adriatic by CLAUS (1878), and was considered rare. This cubomedusa has been reappearing since the 1985 (BOERO & MINELLI, 1986) in few specimens, and since the 1989 in large surface aggregations along the Central and North Adriatic. The biological cycle of this species is not yet well known in the Adriatic, and, at present, the polipoid stage is not detected.

In order to assess its biological cycle, the amplitude of the swarming phenomena, and the relations with hydrological parameters and/or pollution, a joint research effort between the University of Trieste and the Centro Ricerche Marine of Cesenatico was settled from August, 1991.

The specimens of *C. marsupialis* here analyzed were caught in the harbor of Cesenatico in August 1991, in water with a mean deep of 2 m. A sample of 1 thousand specimens was collected. The specimens were immediately fixed in neutralized formaldehyde 4 % in filtered sea water.

Annual variation of temperature and salinity were monthly collected with the aim of a sounding net IDRONAUT O.S. 401, near the sampling station (Fig. 1).

The seasonal distribution of the cubomedusa covers the warmer months, from May to November. Mass swarmings are observed mainly within 500 m from the shore, with a density of up to 50 specimens per cubic meter. In May the specimens are mainly small, with a bell size (diagonal between opposite pedalia) of 1 - 2 cm.

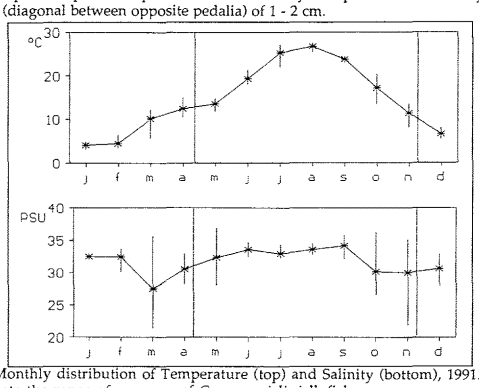

Fig. 1. Monthly distribution of Temperature (top) and Salinity (bottom), 1991. The dotted lines indicate the range of presence of *C. marsupialis* jellyfish.

Parameters measured:	Tot*	min	mean	max
Width between pedalia	100	0.9	2.7	5.0
Min. diagonal of subombrella	100	0.7	1.8	3.0
Height velarium-subombrella	100	1.3	2.4	3.0
Lenght of the gonad	100	0.9	2.0	3.2

* total number of specimens measured

Fig. 2. Biometric data.

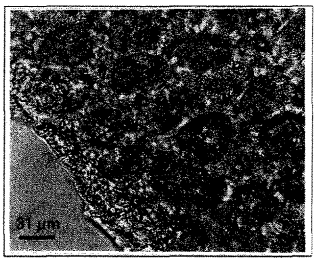

Fig. 3. *C. marsupialis*, ovary

Higher densities are detected from June to September. The presence of the medusoid stage is related with a mean monthly temperature ranging from 11.4 (November) to 26.7 °C (August) and a salinity ranging from 30.0 (November) to 34.1 PSU (September) (Fig. 1).

One hundred of specimens were randomly selected from the sample and measured according to the following parameters :

- the diagonal between opposite pedalia (the max. diameter),
- the min. diagonal of the subumbrella, in the apical region,
- the distance between the velarium, at the rhopalium level and the esumbrellar apex,
- the length of the gonad.

We have also histologically analyzed the gonads (see HERTWIG and HERTWIG, 1879, for a brief description) in twelve specimens to assess the maturity stage. The gonads were post fixed in Osmium tetroxide and embedded in Historesin. The semithin sections (1.5 µm) were stained with methylene blue-basic fuchsin and silver nitrate.

The first biometric observations (Fig. 2) indicate that the *C. marsupialis* development is well-balanced within all the considered parameters, with the exception of the diagonal between pedalia, which exhibits an independent development (range between 0.9 and 5.6 cm). There is no positive relation between the biometric observations and the hydrological parameters. It is indeed possible to observe a wide size distribution in the sample. The degree of maturation in the gonads (both ovaries and testicles), as observed histologically, is also not reliable with the jellyfish size (from 1.5 cm of diam.) (Fig. 3) shows a phase contrast micrograph of an ovary, without maturation gradient.

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Food Webs in the Gulf of Trieste (Northern Adriatic Sea)

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Food webs identified in the Gulf of Trieste (Northern Adriatic Sea) are described from March 1986 to March 1990.

A long term monitoring project of plankton communities has been conducted in the Gulf of Trieste since 1970 (FONDA UMANI, 1991). Structure and temporal trend of phyto- microzoo- and netzoo-plankton communities are described from March 1986 to March 1990 based on biweekly or monthly sampling in a hydrological station 200 m offshore Miramare. Phyto- and microzoo-plankton were sampled by Niskin bottles at four levels (0, 5, 10 and 15 m), while netzooplankton by vertical hauls from the bottom (15 m) to the surface with a WP 2 net (200 µm mesh size). Data of phyto- and microzooplankton are reported as average of the whole water column.

The phytoplankton community included microflagellates, diatoms and dinoflagellates. The most abundant fraction was represented by microflagellates (Chlorophyceae, Prymnesiophyceae, Prasinophyceae, Euglenophyceae, Chrysophyceae and Cryptophyceae) throughout the period from March 1986 to February 1987. Diatoms were significant in spring and autumn, while dinoflagellates are always scarce (fig. 1). The microzooplankton community was constituted mainly by ciliates other than tintinnids throughout the year, tintinnids prevailing in winter and micrometazoa in spring, while other protozoa were very scarce (CABRINI *et al.*, 1989) (fig.2). Netzooplankton was dominated by neritic copepods in all seasons with the exception of summer when cladocerans (mainly *Penilia avirostris*) prevailed. The meroplankton fraction was more abundant during the spring while other holoplanktonic organisms such as chaetognaths, tunicates, etc. had low densities. We distinguished the netzooplankton in four trophic categories (TIMONIN, 1971; RAYMONT, 1983) : herbivores, fine filter feeders, mixed feeders and carnivores. The first was represented mostly by copepods which were more abundant in summer, the second was constituted by *P. avirostris* and tunicates and was prevalent at the end of the summer.

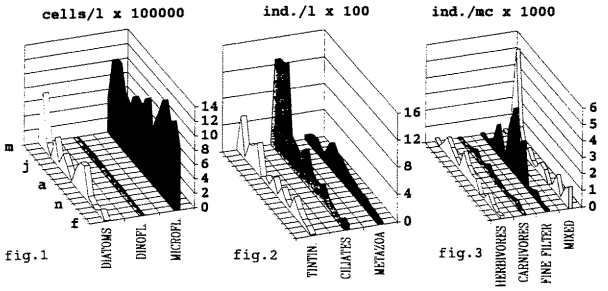

fig.1 fig.2 fig.3

The third, mainly formed by *Acartia clausi*, was dominant in spring, while the fourth (*Podon* spp., *Oncaea* spp., *Sagitta* spp., etc.) was very scarce (fig.3).

The microzooplankton fraction was supported by nanoplankton (ranging from 2 to 10 µm), mainly constituted by microflagellates. In particular, ciliates other than tintinnids seemed to be related with this fraction (fig.4). In fact the increase of nanoplankton was followed by an increase in aloricate ciliates one week later, whereas three or four months later micrometazoa and fine filter feeders substituted as consumers the aloricate ciliates. These latter two fractions seemed to be less efficient in grazing nanoplankton, which reached another maximum in autumn-winter.

Diatoms were grazed by herbivores, but by mixed feeders too (fig.5). Following the spring diatom bloom, an increase of both these components occured about one month later. An opposite trend seemed to occur for diatoms and their consumers, very similar to the preypredator model. Also between herbivores and mixed feeders an opposite trend was evident and, when diatoms decreased, herbivores were substituted by mixed feeders, which can feed on other trophic sources i.e. detritus.

In the second and the third year the microzooplankton fraction diminished and consequently the nanoplankton one increased; diatoms were quite constant, even if a winter maximum was observed. This shift may have determined a variation in the appearance of herbivores; an increase of carnivores was evident and this fact may have influenced the microzooplankton decrease.

We can therefore distinguish two different food webs : the first, supported by nanoplankton is the fastest one and determines the high values of ciliates found throughout the year in the Gulf and the summer abundance of fine filter feeders. The second is supported mainly by diatoms, is the slowest one and influences the temporal trend of herbivores and mixed feeders. Carnivores mostly follow the pattern for herbivore (fig.3), but may be influenced by the microzooplankton trend.

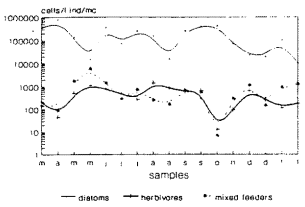

fig.4

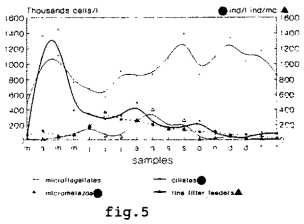

fig.5

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Nutrient and chlorophyll a concentrations in Gruz and Mali Ston Bays (Southern Adriatic)

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Nutrient and chlorophyll a concentrations were measured at two stations in Gruz (N 42°52', E 17°40') and Mali Ston (N 42°40', E 18°05') Bays, during the period February 1988 to February 1989. Secchi disk transparency, temperature, salinity and dissolved oxygen were also measured. All parameters were determined by standard oceanographic methods (STRICKLAND and PARSONS, 1972).

The Station Gruz (25 m maximum depth), is located in the Dubrovnik Harbour in the Gruz Bay, influenced by the open sea waters. The river Ombla estuary provides major quantities of fresh water to the area. The Mali Ston Bay (Usko Station, 12 m maximum depth) is a scarcely inhabited and unpolluted area favouring oyster and mussel farming. Its major eutrophication sources are dense vegetation, water from the river Neretva at the outher part of the Bay and submarine springs in the inner part of the Bay.

This paper establishes whether within the parameters investigated during the research period, there exist significant differences between these Bays. Annual range, arithmetic mean and modal class (range of the most frequent values), standard deviation and Student's t-test P-values of all the measured parameters are presented in Table 1. Low surface salinity values (26.55×10^{-3}-28.31×10^{-3}) were caused by strong precipitation in both bays. The strongest vertical salinity gradient occurred most frequently in the 0-5 m layer in the Gruz Bay ($2 \times 10^{-3} m^{-1}$) and 0-4 m layer in the Mali Ston Bay ($1.8 \times 10^{-3} m^{-1}$). Maximum annual temperature values were recorded at the surface and ranged between 10. 71°C in March and 26.15°C in July, in the Gruz Bay; and 9.51°C in January and 26.83°C in July in the Mali Ston Bay. Winter isothermy occurred in November after a fast cooling of the surface layer which had begun in October. Inverse stratification was recorded during the period December-April. The warming of the surface layer began in May. Thermic stratification of the water column was most pronounced between June and August. In both bays, mixing processes within the water column alternate with stratification. Modal class for Secchi disc transparency was 5.0-6.0 m in the Gruz Bay and 7.5-8.5 m in the Mali Ston Bay. Both bays were well oxygenated. Most frequent oxygen saturation ranged from 1.0-1.1 in the Gruz Bay and 1.0-1.2 in the Mali Ston Bay. Annual alternations between autotrophic, heterotrophic and regenerative phases affect the oxygen saturation level and the nutrient salts concentration throughout the water column. The highest concentration values of nitrates, reactive phosphorus and reactive silicate were recorded in the surface layer, which is in accordance with the maximum fresh water influx. The modal class of nutrient concentrations was higher in the Gruz Bay than the Mali Ston Bay. The N/P ratio modal class in the Gruz Bay ranged from 1-4, whereas in the Mali Ston Bay from 8-16. According to REDFIELD et al. (1963), N/P ratio of 16 is utilized by phytoplankton in forming organic matter. In this study, values between 10 and 40 may be considered as the range which promote phytoplankton growth. A 10-32 ratio was recorded in the Mali Ston Bay through most of the year, which indicates that the Bay is an ecologically stable area. In the Gruz Bay these values were recorded between November and April whereas in 40% of the cases, N/P ratio was below 10, which indicated a large inflow of phosphorus rich sewage waters.

Modal class of chlorophyll a concentration ranged from 0.4-0.6 µg/l in the Gruz Bay, and 0.5-1.0 µg/l in the Mali Ston Bay. Maximum chlorophyll a concentrations (Fig. 1) were mostly recorded at the surface and to 5 m depth in the Gruz Bay, whereas in the Mali Ston Bay at 4-8 m depth which is in accordance with the nitracline and optimal N/P ratio. Relatively lower chlorophyll a concentrations in the Gruz Bay might be result of stronger surface currents and dispersion of phytoplankton populations. According to Student's t-test, statistically significant differences were observed to exist between the Gruz Bay and the Mali Ston Bay in ammonia, reactive phosphorus and chlorophyll a concentrations. Considering the results we concluded the existence of different eutrophication levels. The Mali Ston Bay is a stable, naturally eutrophicated ecosystem, whereas in the Gruz Bay, anthropogenous eutrophication prevails.

Table 1 Physical-chemical characteristics of the seawater in the Gruz and Mali Ston Bays

	GRUZ BAY (n=40)				MALI STON BAY (n=82)				
	Range	Mean	SD	Modal class	Range	Mean	SD	Modal class	P-values
Zs/m	3.0 -13.0	5.9	2.08	5.0 - 6.0	5.0 - 9.0	7.2	1.8	7.5 - 8.5	<0.001
t/°C	10.72-26.15	17.36	4.09	12.0 -16.0	9.51-26.83	16.67	4.62	12.0 -14.0	<0.001
S‰	26.55-38.69	37.21	2.67	37.5 -38.5	28.31-38.69	36.75	2.08	37.0 -38.0	<0.001
ρ/kg/m³	19.50-28.68	26.75	2.04	27.0 -28.0	18.50-28.86	26.83	2.25	27.0 -28.0	NS
O_2/O_2	0.75- 1.36	1.06	0.26	1.0 - 1.1	0.86- 1.32	1.09	0.10	1.0 - 1.2	<0.001
c(NH_4)/µmol/l	0.01- 4.25	0.63	0.79	0.20- 0.40	0.01- 3.98	0.71	0.73	0.01- 0.20	<0.05
c(NO_2)/µmol/l	0.03- 0.25	0.09	0.04	0.08- 0.12	0.01- 1.11	0.15	0.25	0.02- 0.04	NS
c(NO_3)/µmol/l	0.04-21.90	2.25	4.66	0.01- 0.40	0.01- 9.73	0.97	1.54	0.01- 0.20	NS
c(PO_4)/µmol/l	0.01- 2.26	0.27	0.48	0.02- 0.10	0.01- 0.33	0.09	0.06	0.05- 0.07	<0.01
c(SiO_4)/µmol/l	0.44-13.08	3.21	2.57	2.00- 3.00	0.21- 7.15	2.93	1.77	1.50- 2.50	NS
N/P	0.97-47.46	16.63	12.64	1.00- 4.00	2.00-74.00	24.88	22.93	8.00-16.00	-
chl a/µg/l	0.22- 6.15	0.89	1.02	0.40- 0.60	0.21- 6.73	1.47	1.54	0.50- 1.0	<0.05

SD-standard deviation, NS-not significant, P-values (Student's t-test)

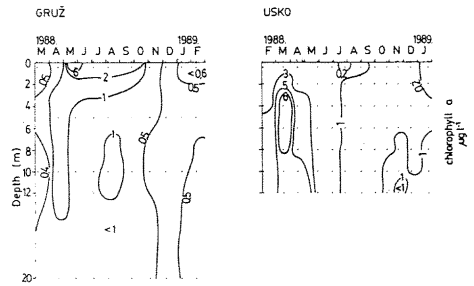

Fig. 1 Distribution of chlorophyll a concentration in the Gruz and Mali Ston Bays

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X

Mucous filaments development under controlled conditions : ultrastructure observations

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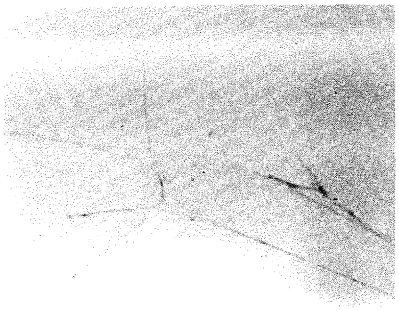
Sea water, collected in the Gulf of Trieste on July 1991, was placed in 10 liters plastic tanks. After eight days in controlled conditions some mucous filaments occurred.

For thin sectioning the filaments were fixed in glutaraldeyde 2.5 % and postfixed for 4 h in 2.5 % OsO_4.

After washing the filaments were dehydrated in alcohol series and embedded in Spurr's medium. The thin sections were cut with glass knives and stained with uranyl acetate and lead citrate. A Philips 201 microscope was used for examination.



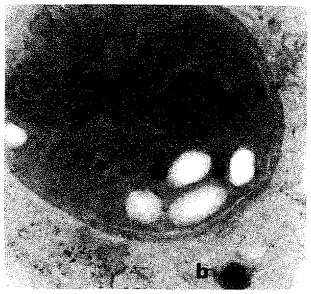
Mucous filaments developed in the tanks.

(——— = 6 cm)

Nitzschia closterium (Ehr.) W. Sm. and marine batecria were the most representative organisms found into mucous filaments.

Electron micrograph of *Nitzchia closterium* apex.

(——— = 0.3 µm)

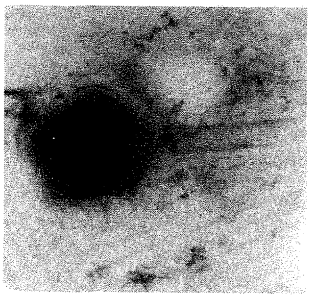


Electron micrograph of a bacterium and bacteriophage.

a. particle classified as bacteriophage according to size and morphology.

b. bacteriophage.

(——— = 0.35 µm)



Electron micrograph of a bacteriophage showing head and tail component.

(——— = 0.1 µm)

Hydrological features and phytoplankton distribution in the Gulf of Trieste (Northern Adriatic) in July 1990 and 1991

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The hydrological features and phytoplankton distribution recorded (AA1, AA2, AA3 and A17) in the Gulf of Trieste are compared (fig. 1).

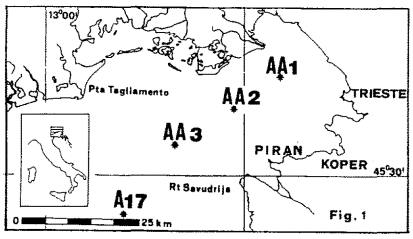


Fig. 1

The data refer to July 1990 and July 1991 when a wide range of mucous aggregates was observed in the Adriatic Sea.

Measurements of salinity, temperature and oxygen were carried out using a CTD Idronaut mod. 401 multiparameter probe. Chlorophyll *a* and phytoplankton samples were collected with a 5 liter Niskin bottle at 0m, 5m, 10m, 15m and deepest water layers.

In July 1990 the values of temperature and salinity were homogeneous along the whole water column. On the contrary, in July 1991 a well defined pycnocline extended over most of the water column (3-12 m). This different situation probably depends on either the absence (1990) and or presence (1991) of fluvial inputs in the spring and at the beginning of the summer.

During July 1990 oxygen distribution was rather homogeneous. The oxygen content generally showed oversaturation conditions over most of the water column except for the deep layer of st. AA1 where undersaturation was noticed (fig. 2). The Chl *a* concentration showed a decrease from the coastal area (st. AA1 to the outer part (st. A17). At st. AA1 and st. AA2 an increase in the deeper layers was noticed (fig. 2). In general this trend was followed by the phytoplankton distribution (fig. 2). In July 1991 oxygen distribution was heterogeneous with the highest values in the intermediate layers (8-12 m) and undersaturation values were presented at the deep layers of all the stations (fig. 3). Chl. *a* had a homogeneous distribution and values lower than in 1990. Also in this case the phytoplankton distribution followed the Chl. *a* concentration (fig. 3). The phytoplankton population consisted mainly of microflagellates, diatoms and dinoflagellates. Microflagellates were the quantitatively predominant phytoplankton component in both years. In July 1990 diatoms prevailed over dinoflagellates while in July 1991 the trend between diatoms and dinoflagellates was the opposite.

In conclusion there was phytoplankton abundance mainly in July 1990. The high values of oxygen found in the intermediate layers in July 1991 were not supported by high values of phytoplankton biomass, particularly microflagellates, on the water column but probably by the phytoplankton present inside the mucous aggregates.

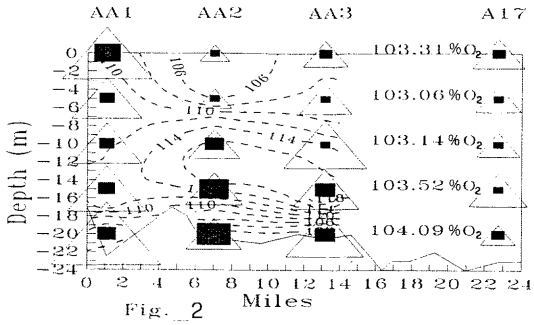
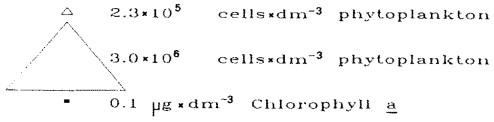


Fig. 2



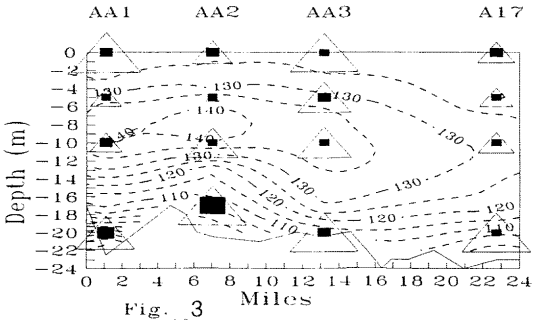


Fig. 3

This work has been supported by the Alpe Adria 1990-91 Project (Friuli Venezia Giulia and Veneto Regions - Italy - and Republics of Slovenia and Croatia)

X

Relation between the tintinnids' distribution, the salinity and total particulate matter in the Middle and Southern Adriatic Sea.

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The distribution of microzooplankton in the Middle and Southern Adriatic during a spring cruise are related to the thermohaline structure of the water masses and distribution of total particulate matter.

In the framework of the C.N.R. Project "Oceanography and Marine Technology", theme "Fluxes", we have studied the microzooplankton populations collected during the oceanographic cruise "Serpa 2" (April 1990) in the Middle and Southern Adriatic Sea (fig. 1). The samples were collected by using a 5 liter Niskin bottle at three levels: surface, intermediate and bottom, at 33 stations, fixed in 4% buffered formaline. Environmental data were collected simultaneously by multiprobe ME 1500.

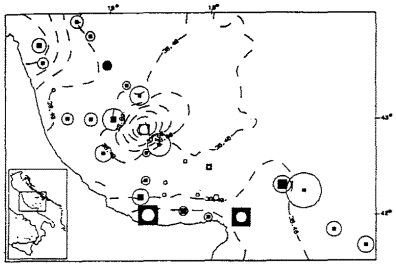

Figure 1: Relation between the salinity and agglutinated and hyaline tintinnids in the superficial layer.

■ = 100 ind.dm^{-3} tintinnids with agglutinated lorica

■ = 50 ind.dm^{-3}

○ = 100 ind.dm^{-3} tintinnids with hyaline lorica

○ = 50 ind.dm^{-3}

--- = salinity

Data on microzooplankton populations are scarse in this area while in the Northern Adriatic Sea their structure, distribution and temporal trend are well known (KRSINIC, 1977). REVELANTE and GILMARTIN (1983) and FONDA UMANI (1991) pointed out the dominance of ciliates other than tintinnids throughout the year, with the exception of winter time, when tintinnids prevail. Among these the species with agglutinated lorica such as the genus *Tintinnopsis* prevail. In the most southern area, microzooplankton populations are constituted by tintinnids, ciliates other than tintinnids, protozoa other than ciliates and micrometazoa. The first ones, studied here were constituted by 61 species (sensu KOFOID & CAMPBELL, 1929; 1939) and prevailed in the whole area in the period of the cruise. 21 ones of these correspond to species identified by KRSINIC (1982) in the same area. Among these the more abundant were the agglutinated species *Stenosemella ventricosa, Dictyocysta lepida, D. elegans* and the hyaline *Steenstrupiella steenstrupii, Dadayiella ganymedes, Eutintinnus elegans, E. fraknoii. E. lusus undae, E. rugosus, E. tubulosus*. Abundance values of total microzooplankton populations, ranging from 0.5 to 251 ind.dm^{-3}, were higher in the southern coastal area and in an offshore water nucleus, corresponding to the South Adriatic branch (1200 m deep). In the first area tintinnids with agglutinated lorica prevail while in the latter one hyaline species are dominant. The agglutination of the lorica is related to the availability of inorganic and/or organic particulated suspended matter (GOLD, 1979), both more abundant in the coastal area. In fact, the prevalence of the tintinnids characterized by agglutinated lorica was confined to coastal waters with lower salinity, while hyaline ones were dominant in higher salinity waters at each layers. An offshore nucleus of abundance of agglutinated tintinnids has been observed in surface layer, corresponding to residual coastal water at low salinity, included in a gyre. (fig. 1). Table 1 shows the total tintinnids are related to total microzooplankton; hyaline tintinnids are better related both to total microzooplankton and to total tintinnids than agglutinated ones; the last ones are inversely related with the salinity and directly related to the total suspended matter, hyaline tintinnids are related to temperature (tab. 1).

Tab. 1

	TM	TT	AT	HT	T	S	TPSM
TM	1						
TT	0.914	1					
AT	0.323	0.281	1				
HT	0.845	0.948	-0.038	1			
T	0.442	0.440	0.159	0.405	1		
S	-0.149	-0.063	-0.271	0.023	-0.096	1	
TPSM	0.211	0.157	0.198	0.098	0.085	-0.349	1

PROB(%)=5, R=0.198

TM = total microzooplankton; TT = total tintinnids; AT = agglutinated tintinnids; HT = hyaline tintinnids; T = temperature; S = salinity; TPSM = total particulate suspended matter

It appears that the agglutinated species need terrigenous inputs for the agglutination of the lorica, therafter they are strictly confined to the neritic coastal area. The hyaline species are widely distributed in the open waters of the Mediterranean, their presence in the South and the Middle Adriatic is related to the ingressions of Southern waters from the Tonian sea. In the investigated area in spring time the microzooplankton populations are very scarse compared to the values of the biomass normally found in the northernmost part of the Adriatic Sea. Their composition differs from the northern community overall in more offshore area, where hyaline species with are dominant.

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Ultrastructure of gelatinous aggregates in the Northern Adriatic Sea

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The formation of large amounts of gelatinous aggregates, containing microalgae, bacteria and protozoa has occurred extensively in the Northern Adriatic waters during summer months since 1988 (HONSELL and CABRINI, 1990-1991; CABRINI *et al.*, 1990). This phenomenon, although it has been reported in historical reviews since 1729, represents a change of the trend observed in the Northern Adriatic Sea in the mid-seventies and early eighties, which were characterized by recurrent red tides caused by monospecific blooms of dinoflagellates (BONI, 1983).

Samples of gelatinous aggregates were collected weekly by SCUBA divers in the Gulf of Trieste (Marine Reserve of Miramare) in the period June-August 1991 to investigate their species composition and fine structure. They were first observed in vivo, before and after staining with toluidine blue to show acid polysaccharides. For electron microscopy the aggregates were fixed with 3% glutaraldehyde in 0.1 M cacodylate buffer pH 7.1, postfixed in 2% osmium tetroxide, dehydrated with an ethanol series and embedded in Spurr resin for sectioning (TEM) or critical point dried and coated with gold/palladium (SEM). Ruthenium red (0.15 %) was added to the post-fixative to stabilize the extracellular polysaccharidic network (AVANZINI and HONSELL, 1984).

Many species of microalgae were present in the aggregates: the diatoms were generally very abundant, but sometimes the dinoflagellates also occurred in high cell numbers. The dominant species observed in the mucilage aggregates in the Gulf of Trieste were not the same during the different years: *Skeletonema costatum* was particularly abundant in 1988, *Thalassiosira sp.* in 1989, and *Nitzschia closterium* in 1991.

Preliminary results indicate that: a) the most abundant species found in aggregates during their maximum development was *Nitzschia closterium*. The cells appeared viable with a well developed frustule and no morphological indication of stress was noticed, different from what occurred to *Skeletonema costatum* in 1988 (HONSELL and CABRINI, 1990-1991). Blue toluidine staining revealed the presence of a polysaccharidic sheath surrounding the cells disposed in long rows (Fig. 1). b) transmission electron microscopy confirmed the presence of a fibrillar network around the cell (Fig. 2). This layer was organised in short and branched chains irregularly distributed in an amorphous matrix. The fibrillar network presented a variable sized mesh (Fig. 3). c) scanning electron microscopy showed various microalgae (mainly diatoms, dinoflagellates and small flagellates), bacteria and detritus embedded in an amorphous matrix with filaments (Fig.4).

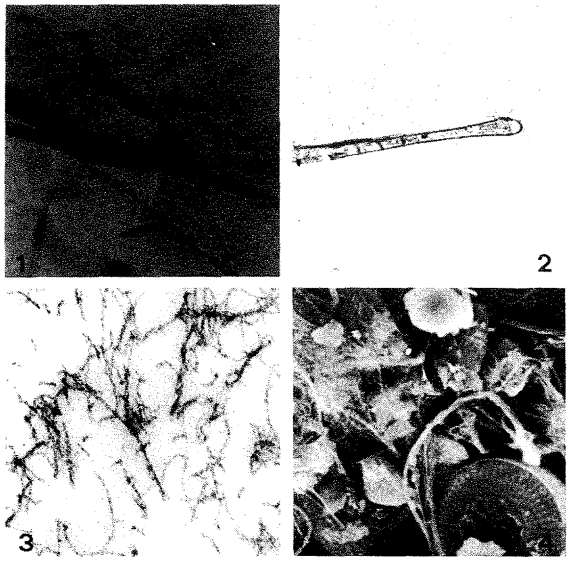

Fig. 1 - Light microscopy: *Nitzschia closterium* stained with toluidine blue: a mucilaginous sheath around the cells is evident. 600x.

Fig. 2 - Transmission electron microscopy: detail of a section of *N. closterium* with a fibrillar network around it. Ruthenium red staining. 5400x.

Fig. 3 - Enlargement of the gelatinous layer with short branched chains. 23600x.

Fig. 4 - Scanning electron microscopy: various microalgae and detritus are entrapped in a tridimensional filamentous network. 6000x.

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X

Phytoplankton carbon biomass in Gruz and Mali Ston Bays (Southern Adriatic)

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According to the annual phytovolume distribution, the Gruz (N 42°52', E 17°40') and Mali Ston (N 42°40', E 18°05') Bays have been included in the same category of moderately eutrophicated ecosystem (VILICIC, 1989), but those bays have different eutrophication sources. Most of the eutrophication in the Mali Ston Bay is caused by washing of nutrient salts from surrounding sediments, whereas in the Gruz Bay, both natural and anthropogenous eutrophication sources abound. Fresh waters from the Ombla river and sewage waters enrich the Gruz Bay with nutrients, whereas open sea waters frequently influence near the bottom layer. This paper compares phytoplankton carbon biomass values between the two bays.

Phytoplankton in the Gruz (Gruz station, 25 m max. depth) and Mali Ston Bays (Usko station, 12 m max. depth) was sampled from February 1988 to February 1989. Phytoplankton samples were preserved with 2% neutralized formaldehyde solution, and their cell counts were obtained by the inverted microscope method (UTERMOHL, 1958). Total cell volume was calculated from cell density and cell volume data of each species, according to SMAYDA (1978). Phytoplankton biomass in terms of carbon content was estimated from total cell volume according to EPPLEY *et al.* (1970). Physical-chemical parameters were determined by standard oceanographic methods (STRICKLAND and PARSONS, 1972).

Annual distribution of total phytoplankton carbon biomass in the Gruz and Mali Ston Bays is represented in Fig. 1. An intense development of the total phytoplankton biomass was registered in the spring-summer period. Temporal distribution of the microplankton (>20µm) and nanoplankton (<20µm) biomass matches seasonal rhythms characteristic of coastal eastern Adriatic waters. Considerable differences were observed in range, maximum and mean annual microplankton, nanoplankton and total phytoplankton biomass (Table 1). Seasonal fluctuations were even more pronounced in the Gruz Bay, where the maximum annual value tripled the values for Mali Ston Bay, and were caused by a more intensive exchange between sewage and the open sea waters. Therefore, when compared to Gruz Bay, Mali Ston Bay is the area of greater ecological stability, in spite of high salinity values and fluctuations in nutrient salts. The Gruz Bay maximum annual nutrient concentration was recorded in April and was caused by fresh water influx from the river Ombla. An intensive development of dinoflagellate *Prorocentrum triestinum* was recorded (119 µg C/l) in May. In both bays, seasonal fluctuations in nanoplankton carbon biomass were less pronounced than in microplankton. The contribution of nanoplankton to total phytoplankton carbon biomass ranged from 53 to 96% in the Gruz Bay, and 36 to 85% in the Mali Ston Bay. The relative contribution of microplankton to the total phytoplankton biomass in the Mali Ston Bay exceeded that of nanoplankton only in March, when the maximum annual microplankton biomass was recorded, and to which the species *Chaetoceros compressus* and *Rhizosolenia stolterfothii* contributed the most. According to frequency distribution data, nanoplankton biomass values mostly ranged from 10-15 µg C/l, and total phytoplankton from 15-20 µg C/l in both bays. Maximum microplankton carbon biomass frequency in the Gruz Bay ranged from 0-1 µg C/l, whereas in the Mali Ston Bay, it ranged from 3-4 µg C/l. Those differences between the bays confirm the prevailing influence of the open sea waters in the Gruz Bay.

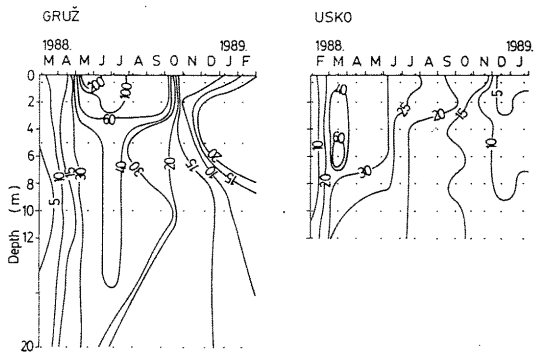

Fig. 1. Distribution of the total phytoplankton carbon biomass (µg C/l) in the Gruz and Mali Ston Bays.

Tab. 1. Temperature (T), salinity (S) and microplanklon (M), nanoplankton (N) and total phytoplankton carbon biomass in the Gruz and Mali Ston Bays.

	Gruz Bay (n=46) Range	Mean	SD	Mali Ston Bay (n=83) Range	Mean	SD
T (°C)	12.9 - 26.1			9.5 -26.8		
S x 10^3	26.55- 38.66			28.31-38.87		
M (µg C/l)	0.11-168.59	9.47*	28.11	0.24-55.23	6.28*	7.81
N (µg C/l)	2.61- 78.03	24.74*	17.54	2.79-29.5	12.25*	6.07
Total (µg C/l)	3.07-246.62	33.94*	42.56	5.01-64.32	18.53*	9.89

Means at the same line followed by * are significantly different (P<0.001, Student's t-test), SD = standard deviation

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X

Tintinnid ciliates in the stratified water column in the Gulf of Trieste (Adriatic)

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During 1989-1991 a study of tintinnids and other microzooplankton components has been carried out in the southern part of Gulf of Trieste. Tintinnids were monitored over three years, two of which were characterized by the massive presence of mucus macroaggregates.

Tintinnids were sampled monthly with a 5-l Niskin bottle on three stations at three depths in the southern part of Gulf of Trieste (Adriatic sea). Organisms were determined and enumerated under a Wild invert microscope. Tintinnid loricae were measured in order to estimate lorica volume for apropriate shape for biomass estimation. The relationship between lorica volume and carbon content of VERITY & LANGDON (1984) was used for conversion .

Twenty-nine tintinnid species were determined. The tintinnid spring community was dominated by *Helicostomella subulata*, *Stenosemella nivalis* and *S. ventricosa*, while in the summer the species of the genera *Eutintinnus*, *Tintinnopsis* and *Favella* were important. Other genera occured rarely in low numbers.

Seasonal dynamics of tintinnid biomass during the period of water column stratification showed large differences between the three years. High values of tintinnid biomass in the late summer period in 1989 were probably a consequence of the intrusion of south Adriatic water as indicated by the presence of open sea species. The total tintinnid biomass ranged from 0.2 mg C/m² in May to 33 mg C/m² in September. Distinctly lower values were obtained for the spring-summer period 1990 and varied from 0.2 mg C/m² to 19.4 mg C/m² . The lowest biomass was encountered during 1991, reaching a maximum of only 4 mg C/m² in mid July. Only the spring-summer 1989 data were comparable to those of REVELANTE & GILMARTIN (1983) for stratified conditions in Northern Adriatic - 57 mg C/m².

The September peak of tintinnid biomass in 1989 and 1990 is probably evidence of the resting cyst phenomenon. We found small specimens of *Helicostomella subulata* in great numbers in the near bottom samples.

It also seems that tintinnid biomass was adversely influenced by the occurence of mucus aggregates in the water column.

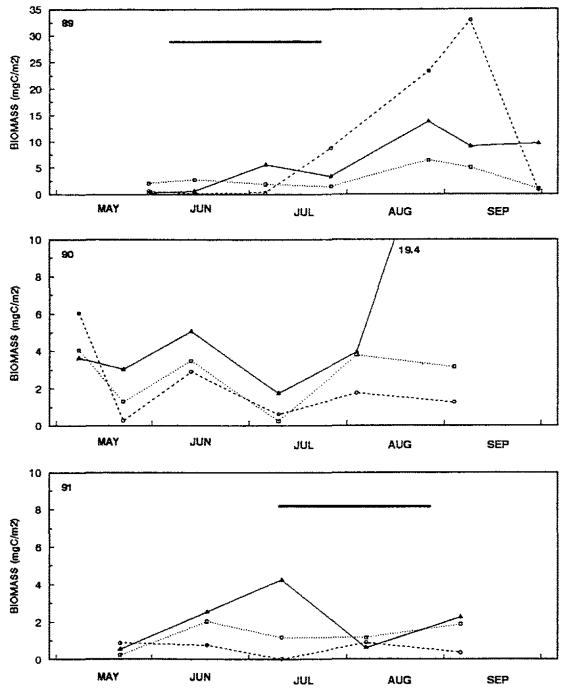

Fig. 1 Tintinnid biomass (mg C/m^2) in a stratified water column at three stations in the southern part of the Gulf of Trieste during 1989, 1990 and 1991 (note the scale difference). Time periods denoting the massive occurence of mucus aggregates is delineated by the bold line.

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Mucous filaments development under controlled conditions : some detected organisms

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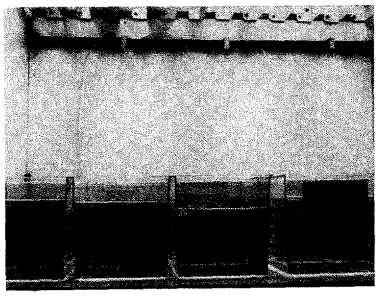


Sea water samples under controlled conditions

During July 1991 surface sea water samples (50 liters) were collected in the Gulf of Trieste.

10 liters of water was directly placed in plastic tanks, 40 liters were filtered through different meshes (10 l through 150 µm mesh, 10 l through 20 µm mesh, 10 l through 10 µm mesh and 10 l through 1.2 µm filter).

The tanks were placed under controlled conditions: 12 cool-white fluorescent lights on a light-dark cycle of 16:8 at 20°C.

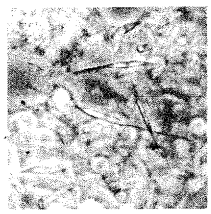
Mucous filaments developing inthe tanks.
(—— = 6 cm)

After eight days the formation of some mucous filaments in the not filtered water occurred.

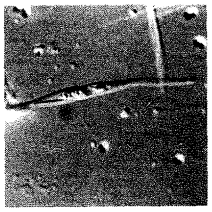
Two days later, mucous aggregates were detected also in 150 µm filtered water.

The filaments were observed under light microscope and SEM.

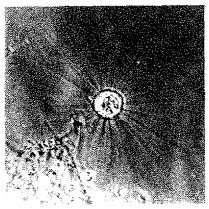
The most representative organisms were measured and photographed.



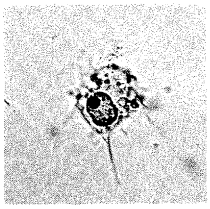
Mucous filament observed under inverted microscope.
(—— = 25 µm)



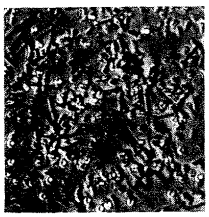
Nitzschia closterium (Ehr.) W.Sm.
(—— = 15 µm)



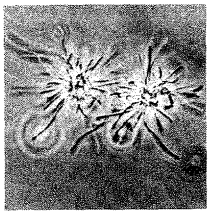
Heliozoan.
(—— = 20 µm)



Ameboid form.
(—— = 30 µm)



Coccoid and filamentous bacteria.
(—— = 8 µm)



Unidentified not photosynthetic form.
(—— = 100 µm)

Small scale structure of the phytoplankton biomass in the Gulf of Trieste (North Adriatic)

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Sampling of biological parameters such as biomass of plankton organisms and chlorophyll a concentrations was carried out in the Gulf of Trieste, the depth of which does not exceed 30m. Sampling was restricted to a spatial scale of a few metres. This fact presents a limitation in estimating the standing crop of phytoplankton since its concentration is probably constrained by physical processes which occur over small spatial scales of the order of 1m or less (COWLES *et al.*, 1990). Therefore, a small scale profiler (F-probe), developed by the Centre for Water Research, Western Australia, was used to observe changes in the vertical distribution of temperature and Chl *a* with a vertical resolution of about 3 cm for a conventional drop speed of about 1 m/sec. The fluorescence of Chl *a* was measured with a Sea Tech fluorometer mounted on the probe.

Vertical profiles of the water column temperature and Chl *a* concentrations were measured in September and October 1991 at six stations in the southern part of the Gulf of Trieste (surface area of the Gulf approx. 20 x 30 km2). Discrete samples were taken at four depths (0, 5, 10m and bottom) and Chl *a* determinated fluorometrically (STRICKLAND and PARSONS, 1972).

From profiles measured in September it was found that Chl *a* vertical distribution was related to the temperature stratification of the water column (Fig.1). On the same figure the results of Chl *a* analyses from discrete samples are shown (signs). Maximum values were found at 16 and 17 m. At the first group of stations in the Gulf of Trieste (KK, CZ and G) the highest concentrations started at 8m depth, while at the second group of Gulf stations (M, F and F1) they were restricted to a thin layer of the water column (from 14,7 to 18,5m). This distribution agrees well with the stratification. The first group of stations had developed stratification below 9 m depth, while the second one had a thermocline which was deeper and more pronounced. F-probe profiles showed that yet unknown horizontal inhomogeneity of meteorological conditions (wind field mainly), which led to intense surface mixing of the water column at some stations (M, F and F1), was present. As a consequence, a temporary affinity of hydrographic properties occured within the first and the second group of stations of the Gulf at the sampling time.

In October the phytoplankton biomass was displaced deeper into a thin layer close to the bottom. Chl *a* vertical distribution followed the temperature structure. The deep thermocline (ranging from 16 to 22m) was the result of wind mixing and convection due to surface cooling. Below the thick mixed layer Chl *a* concentrations started to increase, reaching their maximum values at the bottom or approx. 1m above it (Fig.1). The exception was station M (28m depth), where a relatively sharp thermocline from 22 to 28 m prevented phytoplankton from settling.

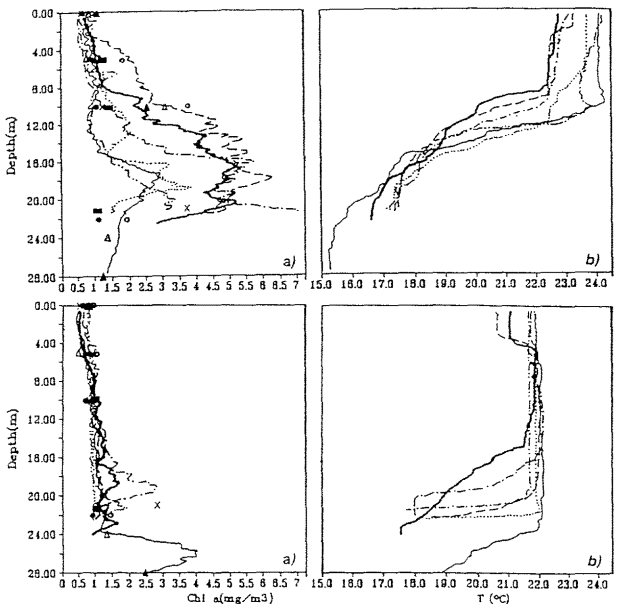

Figure 1: Vertical profiles of chlorophyll *a* (a) and temperature (b) done on September (top), and October 1991 (bottom).

Profiles using F-probe (curves) and values of laboratory analyses (signs) were performed at stations:
CZ (—— and ▲), F (—·— and ■), F1 (····· and ●), G (– – – and ○), KK (—·· and x), M (—— and ▲).

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X

Trophic characteristics of the Sibenik Bay (Middle Adriatic)

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The Institute of Oceanography and Fisheries has performed the monitoring of physical, chemical and biological properties of the sea water at five stations in front of major Dalmatian towns (Zadar, Sibenik, Split, Ploce and Dubrovnik) ever since 1976.

The present paper presents the results of 14-year research of plankton parameters (phytoplankton density and biomass, zooplankton biomass, and diatom/dinoflagellate ratio), and the most important factors affecting this community (N-salts, P-PO_4, O_2 saturation, transparency). Data used were from Institute's internal publication (Studies and Reviews, 1977-1991).

Sibenik Bay was chosen (station S1) as an area of the highest, IV trophic level of Dalmatian area (VILICIC, 1989). Progressive eutrophication has caused very prominent changes in the plankton community which should be emphasized.

Plankton parameters are an order of magnitude higher here than at other stations. Sibenik Area Station S1 Position : 43°44'0"N; 15°53'5"E; Depth : 32 m Krka River discharges and town effluents are principal sources of eutrophication.

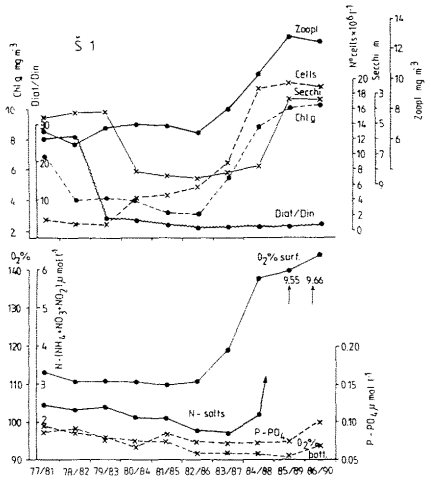

Fig.1 : Annual trend in biological and chemical parameter in the Sibenik area, expressed as 5-year running averages.

Surface layer, where photosynthetic activity is most intensive, was taken into account, except for O_2%. Observations are for summer only. This layer is most strongly affected by land runoff in summer due to intensifica-tion of municipal effluent discharge and the presence of a pycnocline. Fig. 1 shows the variations of studied parameters. As of 1980/84, biological parameters have constantly increased, reaching the highest values for the most recent annual series. Surface chlorophyll *a*, observed over 5-year periods, ranged from 2.84 to 11.65 mg m^{-3}, phytoplankton density from 1,800 to 19. 400 x 10^6 cells l^{-1}, whereas zooplankton biomass varied from 5.7 to 12.8 mg m^{-3} (vertical hauls), REGNER (1991) recorded progressive changes in zooplankton copepod community between 1985 and 1988, ascribing them to coastal water eutrophication.

Progressively higher oxygen saturation points are ascribed to increased photosynthetic activity in the surface layer. Although O_2 saturation had never been below 100%, it has recently reached values as high as 140%. However, bottom oxygen saturation tends to decrease as expected, even though the station is rather shallow.

Higher plankton quantities induced a reduction in the sea water transparency. Phytoplankton composition has also changed, so that the diatom to dinoflagellate ratio has been considerably altered in favour of dinoflagellates. *Prorocentrum minimum*, one of the species taking part in summer phytoplankton blooms in this area, has developed ever more intensive summer blooms (MARASOVIC, 1990). A greater proportion of dinoflagellates in the phytoplankton community, as a consequence of environmental enrichment, is well known in other coastal areas of the eastern Adriatic, as well (MARASOVIC and PUCHER-PETKOVIC, in press).

Whereas phosphates remained at the same level throughout the period of our research, the most recent annual series show an enormous increase of N-salts, particularly nitrates.

To conclude, described changes have in fact taken place in a relatively short time. The continuity of these processes are of serious concern, since they are indicative of the fact that natural fluctuations have been overwhelmed by land effects.

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The effect of eutrophication on the Copepods of the Adriatic Sea

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The aim of this paper is to determine the consequences of progressive eutrophication effects caused by human activity on the composition and density of copepods.

Zooplankton material for this study was collected from bottom to surface at five stations in the eastern Adriatic with HENSEN plankton net (73/100, silk N° 3). One of them was in the coastal waters in front of Dubrovnik (Gruz) harbour, two in the Vela Luka Bay (channel region of the middle Adriatic) and the last two in the open middle Adriatic) and the last two in the open middle Adriatic (Fig. 1).

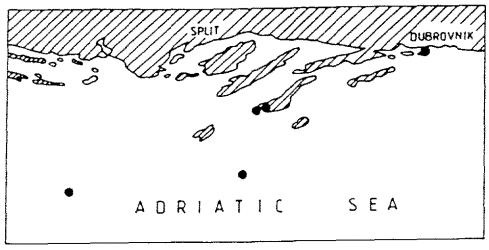

Fig.1 The study area

Fifteen years of investigations (1977-1991) on copepods in front of Dubrovnik harbour have shown that about 30 species are present in summer (REGNER, 1986, 1987, 1989, 1991). Although some predominantly pelagic copepods such as : *Neocalanus gracilis, Calocalanus plumulosus, Clausocalanus parapergens, Pleuromamma gracilis, Heterorhabdus papilliger, Corycaeus flaccus* and some others appear from time to time, neritic species usually occur with higher densities. *Acartia clausi* is always dominant in summer, with an extraordinary high percentage of up to 80 %. In 1991, the percentage of *Acartia clausi* was 93% of all other copepods. In addition recent results (July 1991) indicate that the density of copepods show an increasing trend of about 1300 copepods/m^3 . The increasing trend of the percentage of *Acartia clausi* and the increasing copepod density we can connect with the progressive eutrophication of eastern Adriatic coastal waters and the increasing phytoplankton density in fifteen years period.

In Vela Luka Bay, about 35 species of copepods were found in 1990. The maximum number of species was found at the entrance to the bay, exposed to the strongest impact of open sea waters. Nevertheless, the species composition is diverse in the inner part of the bay, with some pelagic species in addition to those of neritic origin. So, the presence of the copepods: *Lucicutia flavicornis, Mecynocera clausi, Euchaeta hebes, Heterorhabdus pappiliger* and some others, predominantly pelagic species, indicate a mixing of coastal and pelagic influences throughout the study area. Dominant copepods were: *Acartia clausi* constituting as much as 93% in July, *Centropages kroyeri* (up to 50% in autumn), *Temora stylifera, Labidocera wollastoni* etc. Apart from the high percentage of *Acartia clausi* in summer, the eutrophication effects of human activities can be seen in the inner part due to an unexpected high biomass for such a shallow station. This phenomenon was observed especially in summer.

At stations close to the Jabuka Pit and Palagruza (open waters of the middle Adriatic), about 50 species of copepods were found. Although this number is smaller then expected, we can explain it by seasonal samplings of zooplankton in 1986 and 1987. *Ctenocalanus vanus*, the most wide-spread Adriatic species was dominant of the present copepods with about 11%. Furthermore *Acartia clausi* was present by 6%, *Clausocalanus jobei* by 4,6%, *Centropages typicus* by 4.4% etc. From time to time, with just a few specimens : *Clausocalanus mastigophorus, Calocalanus plumulosus, Clausocalanus parapergens, Haloptilus longicornis, Lucicutia flavicornis, Macrosetella gracilis, Scolecithricella dentata, Corycaeus flaccus* and some other predominantly pelagic species appeared, as a consequence of dynamics of water masses and mixing of coastal and open-sea waters at the studied stations. The number of copepods per m^3 is low-about 112/m^3 which is usual for open waters of the middle Adriatic.

Conclusions

From the results mentioned above we conclude:

1. The recent results in front of Dubrovnik (coastal sea) have shown progressive changes under the influence of eutrophication, such as the increasing trend of the percentages of *Acartia clausi* and the increasing copepod density.
2. In the Vela Luka Bay (channel region) the eutrophication effects of human activities can be seen in the upper part of the bay through unexpectedly high biomass and high percentage of *Acartia clausi*, too.
3. No changes have been recorded yet from the open middle Adriatic.

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X

Do gelatinous "Macroaggregates" in the northern Adriatic influence the biomass dynamics of free-living microheterotrophs ?

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An investigation of the effect that gelatinous "macroaggregates" have on the smaller size classes of free-living plankton was conducted during the periods of summer stratification in 1986, 1987, 1988, 1989 and 1990. Sampling was conducted along a trans-Adriatic trophic gradient from off the Po delta, Italy (sta's 10, 9) to the Istrian peninsula, Croatia (sta. 6), and southward toward the middle Adriatic (sta. 23). Water column plankton populations were enumerated by epifluorescent or inverted microscopy. The analysis of autotrophic populations is currently being published (REVELANTE and GILMARTIN, 1992). Herewith are reported some of the observations on the microheterotrophs.

The primary production, and dependent trophic levels, of the pelagic food web of the northern Adriatic fluctuate widely as a function of interannual differences in the Po River nutrient input (GILMARTIN *et al.*, 1990). In 1986 and 1988 the "Po effect" was strong relative to other years yet, fortuitously, gelatinous "macroaggregates" were strongly developed during the 1988 cruises and absent during the 1986 cruises.

The free-living phytoplankton populations in the ambient water did not exhibit a significant difference in the amplitude of cell densities in 1986 (a nonaggregate year), and 1988 and 1989 when large phytoplankton containing "macroaggregates" were present. During all years the biomass dynamics of the free-living autotrophs were primarily related to the temporal characteristics of Po River discharge and/or horizontal advection of Po waters, and were independent of the presence or absence of "macroaggregates" (REVELANTE and GILMARTIN, 1992).

Similar trends are here reported for the microheterophic populations of free-living bacteria. The data are summarized in Figure 1. which presents the average mean water column densities of microheterotrophs along the west to east trophic gradient, and southward, during the summer stratified seasons of 1986, 1987, 1988 and 1990.

The densities of free-living heterotrophic bacteria at western stations (10, 9) had similar amplitudes in the "macroaggregate" year 1988 compared with other years when "macroaggregates" were not present. The spatial distribution of free-living heterotrophic bacteria, and the observed gradients, mirrored those of the small pico-autotrophs, and were primarily related to hydrographic conditions. Preliminary analysis also indicate that other microheterotrophs (unpublished data), such as microflagellates and ciliated protozoans, also did not significantly increase in the ambient water when "macroaggregates" were present.

During the sampling cruises high densities of free-living heterotrophic bacteria were observed in both 1986 and 1988, strongly implying that the presence of high abundances of large "macroaggregates" in 1988 did not influence the biomass of free-living water column populations. However attached microheterotrophic populations, associated with micro-flocs and larger aggregates, did increase significantly during "macroaggregate" years (REVELANTE and GILMARTIN , 1992).

In addition, in 1986 and 1988 the oceanography of the northern Adriatic, combined with the discharge characteristics of the Po River, created a circulation pattern under which the "Po influence" was strong in eastern, and even in southern waters. Yet, over the entire range, freeliving microheterotroph population densities differed little between 1986 and 1988 despite 1986 being a non-aggregate year.

These data indicate that during the stratified season the population distribution and biomass characteristics of the free-living smaller plankton size classes in the water column, whether autotrophs or heterotrophs, wasn't changed by the presence of gelatinous "macroaggregates". This strongly implies dependent elements of the pelagic food web in the region were similarly unaffected.

We speculate that in "macroaggregate" years a separate and distinct food web is introduced into the northern Adriatic ecosystem, which is superimposed on top of the basic pelagic food web. The "packaging" of the new organic substrate, represented by the "macroaggregates" creates a spectrum of larger than usual particle size classes which are thus unavailable to extant pelagic consumers. As a consequence it is probably processed by a microbial loop through a distinctly separate food web directly and physically associated with the "macroaggregates". Therefore we conclude that "macroaggregates" contribute to the pelagic food web primarily through decomposition and nutrient regeneration rather than by serving as "prey" for primary consumers. This conclusion in no way ignores the impact that sinking "macroaggregates" may have on the benthic community, but only to the impact they may have on the pelagic community.

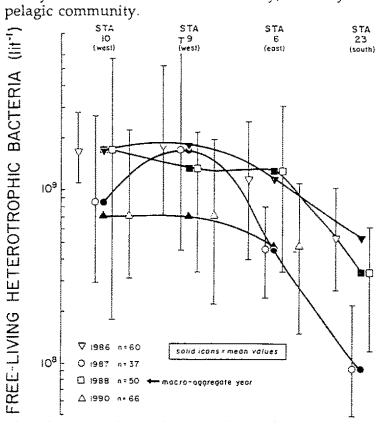

Fig. 1. The regional and temporal distribution of microheterotrophs. Filled icons (v) are annual mean icons repositioned so that their curves nest vertically.

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Phytoplankton seasonal trend in the coastal waters of the Northern Adriatic Sea (Alpe Adria Project, March - July, 1990)

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In the frame of the Alpe Adria Project, a serie of 10 cruises was carried out by the Institutes of the Adriatic Regions during the period March-July, 1990, on 10 stations located in the coastal waters of the Northern Adriatic Sea (see fig. 1). This paper deals with the phytoplankton observations performed in this period.

The meteorologial and hydrological conditions of 1990 were characterized by low freshwater inputs coming from major rivers into the basin; therefore, the absence of an evident diluted surface layer favoured the intrusion of high salinity waters from south, so influencing not only the intermediate and deep layers but the surface waters too. Nutrients are generally present with low concentrations, only showing an increase in the western diluted waters in the samples of May (FRANCO, 1990).

Phytoplankton abundance reflects the hydrological dynamics: in the whole basin, during the early spring (March and April), phytoplankton communities were present in low cell numbers, mainly dominated by microflagellates. In the first part of May, a diatom growth was observed in the whole sampling area: this phenomenon was more evident in the S-W portion of the basin, strictly influenced by the Po and Adige rivers (more than 10^7 cells/l). Moving clockwise, till the southern part of Gulf of Trieste, diatom number decreases (from 2 to 0.7 10^6 cells/1). As species composition, *Cyclotella* sp, *Nitzschia delicatissima* complex and *Nitzschia seriata* complex were diffused everywhere.

After the diatoms drop, microflagellates increase till the end of June, showing peaks of 3.3, 2.4, and 4.7 10^6 cells/l, respectively in the plume of the Po river, in the northern and southern waters of the Gulf of Trieste. The month of July was characterized by a reduction of phytoplankton biomass and by a high species diversity, most of them representative of summer Adriatic communities, as *Rhizosolenia alata*, *Cerataulina pelagica*, *Chaetoceros* sp, in addition to *Nitzschia delicatissima* and other entities already observed.

During the sampling period, dinoflagellates increase, reaching 15% of the total; they are mainly represented by unarmoured forms, as *Gymnodinium* and *Gyrodinium* spp and by species belonging to the *Prorocentrum* genus, as *Prorocentrum micans*, *Prorocentrum minimum* and *Prorocentrum aporum*.

As conclusions, we can assess that, during the 1990 spring, phytoplankton communities were dominated by microflagellates, according to previous reports (SOCAL *et al.*, 1982), with highest abundances in the eastern waters (FANUKO, 1980). The diatom bloom was limited to a short period, with maxima in the S-W waters influenced by the Po river (see SOCAL and BIANCHI, 1989).

Phytoplankton vertical distribution, referred to the stability of the water column, was more evident in the western waters, showing higher abundances in the narrow surface layer, directly influenced by river outputs. In these waters, the high observed variability suggests that mesoscale processes are more significant here than in other coastal areas.

During the sampling period, no gelatinous aggregates were observed; the only exception was a report about some filamentous materials noticed in the Gulf of Trieste (end of June).

The general oceanographic conditions are not comparable with those recorded earlier (1988 and 1989) and later (1991), during which periods widespread "dirty sea" phenomena were observed (BRAMBATI, 1988; MARCHETTI *et al.*, 1989).

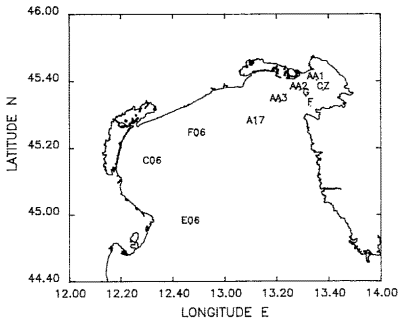

Fig. 1.- Sampling stations.

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X

Long term observation of Phyto and Zooplankton in the open middle Adriatic (1961-1981)

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The results of analyses of multiannual density (1961-1981) of some herbivore zooplankton groups (Copepoda, Appendicularia, Cladocera and Thaliacea) in relation to density changes of phytoplankton at the station Stoncica in the open middle Adriatic are presented.

Introduction

Earlier studies report that high zooplankton concentrations were found in different seas as well as in the Adriatic waters simultaneously with low phytoplankton concentrations and *vice versa* very dense phytoplankton populations in the areas with very poor presence of zooplankton. The goal of this paper was to establish the relationship between prevalently herbivore zooplankton groups and phytoplankton density over a long term interval.

Materials and methods

Phytoplankton samples were collected by Nansen bottles at 0, 10, 20, 30, 50, 75 and 100 m depths. Density is expressed as the number of cells per liter referring to the mean value for all sampled depths. Zooplankton material was collected by vertical Hensen net hauls from the bottom to surface (100-0 m). Density is expressed as the number of individuals per cubic metre.

Results and discussion

Studies of long term fluctuations (1961-1981) of the total phytoplankton at the station Stoncica in the middle Adriatic, show a constant trend of phytoplankton density increase as well as that of primary production (PUCHER-PETKOVIC *et al.*, 1988) for the past few years. We attempt to establish the way individual zooplankton groups respond to phytoplankton density changes. We found that the trend of increase in the numbers of Thaliacea and Cladocera groups coincided broadly with the long term increase in phytoplankton density. A year lag was recorded in Thaliacea in relation to phytoplankton density increase (Figure 1a). Relatively poorer increase in numbers of Copepoda group coincided in time with intensive phytoplankton growth (Figure 1b). Long term phytoplankton fluctuations did not coincide in time with the changes in Appendicularia numbers even though some earlier studies reported that this zooplankton group most readily responded to an increase in primary production (VUCETIC & PUCHER-PETKOVIC, 1969).

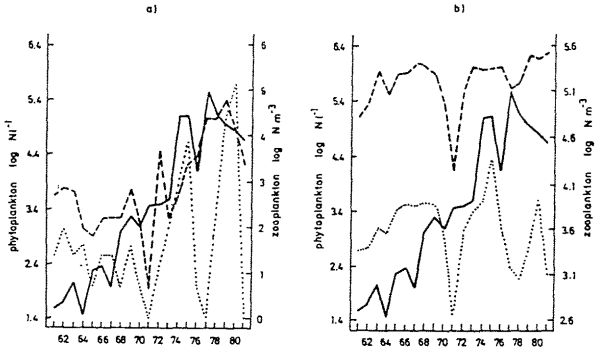

Fig. 1 Multiannual fluctuations in **a)** Cladocera (----) and Thaliacea (....)
b) Copepoda (----) and Appendicularia (.....) density in relation to phytoplankton fluctuations (——) (Stoncica, annual means 1961-1981).

Conclusions

A comparative analysis of multiannual variations of phyto and zooplankton in this area shows that an increase in phytoplankton density results in an increase in the number of Cladocera and Thaliacea. In Thaliacea a year lag in density increase was observed. The increase trend was slightly poorer in Copepoda whereas no increase trend was observed in Appendicularia.

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X

Remarks on a method to quantify total biomass of the benthic communities on artificial substrata

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Although the artificial reefs were pointed out as an efficient tool in increasing fish production, up to now only few researches have contributed to quantify the biomass of benthic community settled onto the substrata (BOHNSACK and SUTHERLAND, 1985). In Mediterranean sea biomass studies were carried out on mussel beds settled on artificial reefs in Adriatic sea (FABI *et al.* 1985, BOMBACE, 1982), whereas RELINI and CORMAGI (1989) reported results on the fouling wet weight mesured on some panels of asbestos along the Ligurian sea.

Aim of this paper is to suggest a method to estimate benthic biomass on artificial substrata using data obtained with the usual sampling techniques for hard substrata.

A five-cube pyramid structure laid in the north Adriatic sea off Porto Garibaldi (see BOMBACE, 1982 and BOMBACE *et al.*, 1989 for further details) was sampled in July 1991, three years after its deployment. It was chosen a three-stage sampling. The reef had no available inner surface, because cubes were fused each other due to blocks movement on the soft bottom. From the population (the whole pyramid surface) a sample of four faces (an horizontal and a vertical one for each layer) was considered. Each one was divided into three equal size nonoverlapping strata and three 10x10 cm surface units were collected from it, one unit per strata. It was taken a census of any 100 cmq unit ; this area was pointed out as an adequate area, after plotting cumulative number of species against increasing areas in the same structure. It was used a non probabilistic scheme because in explorative survey it was proved to be more adequate than the probabilistic one and, in particular, the quota sampling was chosen at the second stage, owing to the high variance of the studied variable, the biomass. Zoobenthic biomass was measured as decalcified wet weight for each sampling unit. Identified taxonomic groups were put into trophic categories and their relative contribution was calculated.

To verify if the biomass distribution was associated to the identified strata, a chi-square test was performed both for the horizontal and the vertical surfaces. There was a mild association for the horizontal surfaces, whereas a really strong association was found for the vertical faces (SIEGEL, 1966).

In order to quantify the total reef biomass a bivariate interpolation technique, the G3GRID of SAS with the spline option, was used. Each sampling unit was identified by three coordinates: the first two indicate unit position on the reef (x,y) and the third rapresentes the biomass (z). The biomass of an area was considered as function of geographical coordinates, z=f(x,y), of that area. A foundamental assumption was so made : the amount of biomass depends on the area position in the reef surface. Once obtained the biomass estimates for the four faces considered, a total biomass was evaluated for the whole structure and for the single cubes taking into accont the structure shape.

The three-dimensional graph hilights an increase of the total biomass from the lower to the upper layer on the horizontal surfaces, showing also maximum values on the central zone (Fig.1). The same trend is evident through the vertical faces but, in this case, low values are given in the central part (Fig.2). Difference on biomass distribution is probably due to effects of surface discontinuity (DI PISA & RIGGIO, 1982).

The biomass estimated is 4.59 Kg/m2 for the vertical faces of the upper boulder and 1.42 Kg/m2 for the horizontal one. The exposed faces of the bottom layer show 1.41 Kg/m2 on the vertical surfaces and 0.52 Kg/m2 on the horizontal. On the whole, the structure has 112.66 Kg as total amount of biomass calculated on the concrete surfaces (not including holes): 60.4% percent on the single cube of the upper layer and 39.6% on the four cubes below.

Benthic community is characterized by total absence of macroalgae, whereas vagile and sessile zoobenthos species are dominant. Filter-feeders represent 97.88% of the total samples biomass, 61.53% of which are mussels and oysters, 17.41% serpulids, sabellarids, small-sized bivalves, barnacles and ascidians and the last 18.94% non-active filter-feeders as hydroids and actinarians. Other trophic groups are deposit-feeders (0.74%), omnivorous (0.41%) and carnivorous (0.12%).

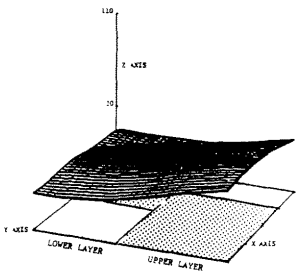

Fig.1 - Three-dimensional graph of total biomass for the horizontal faces. View of the pyramid surfaces.

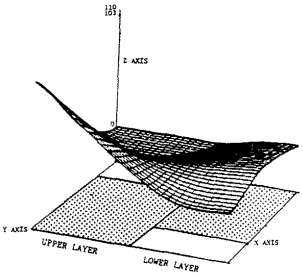

Fig.2 - Three-dimensional graph of total biomass for the vertical faces. View of the pyramid surfaces.

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Essai d'évaluation de l'impact d'un récif artificiel expérimental dans le golfe du Lion

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L'aménagement physique du milieu marin par l'emploi de récifs artificiels constitue une piste de réflexion prospectée depuis une vingtaine d' années, en complément aux mesures de gestion des pêches, le long du littoral français de Méditerranée (DUCLERC *et al.*, 1985). Pour tenter d'évaluer les impacts de telles réalisations, on a procédé en 1985 à la construction de cinq ensembles récifaux composés de structures creuses en béton de deux types : des modules parallélépipédiques de 150 m³ et des modules polygonaux de 10 m³, immergés au large du littoral du Languedoc-Roussillon. Ce "Programme d'étude des récifs artificiels en Languedoc-Roussillon" a été mené en collaboration entre l'Ifremer et le Cépralmar.

L'évaluation de l'impact de ces aménagements a été tentée à travers deux voies d'investigation. D'une part des pêches expérimentales au filet maillant, réalisées simultanément sur un site d'immersion et sur un site témoin localisé sur la même sonde à une distance d'un mille environ, entre mars 1986 et juin 1987 (42 opérations de pêche). D'autre part, l'activité de pêche professionnelle d'un des ports proches d'un des ensembles récifaux (Gruissan) a été suivie par enquêtes suivant un plan d'échantillonage stratifié (FARRUGIO et LE CORRE, 1984) pendant deux fois quinze mois, immédiatement avant et après l'immersion du récif (DUCLERC et BERTRAND, 1992). Le récif de Gruissan, d'un volume de 6000 m³, est situé sur un substrat meuble sablo-vaseux par 27 à 28 m de profondeur. Son emprise au sol est d'environ 1,5 ha.

Les pêches expérimentales ont permis d'identifier 39 taxons, dont 34 sur le site du récif et 28 sur le site témoin. Trois groupes d'espèces ont été considérés, (i) des espèces associées à la présence ou à la proximité d'un fond rocheux *(Palinurus elephas, Diplodus vulgaris, Phycis phycis)*, capturées uniquement à proximité immédiate des structures récifales, (ii) des espèces qui, bien qu'abondantes dans les deux secteurs, paraissent montrer une affinité pour la zone aménagée *(Trisopterus minutus, Spicara maena)* et enfin *(iii)* des espèces sans affinité pour un secteur particulier mais dominant sur le plan pondéral *(Boops boops, Scombrus scombrus, Solea vulgaris, Merluccius merluccius)*.

La moitié des espèces capturées sur le site témoin et près de 60 % de celles qui ont été observées sur le récif ne sont apparues que dans 10 % des relevés. Les indices de dispersion déduits des deux séries d'observations sont très proches : indice de SHANNON (1948) de 1,28 pour le site témoin et de 1,26 pour le site du récif. De plus, le coefficient de corrélation de rang de Spearman (*in* SCHERRER, 1984; ts = 0,73) indique que la corrélation entre les deux distributions est très significative.

La flottille de pêche professionnelle de Gruissan comprend une quinzaine de bateaux qui exerçent leur activité essentiellement dans la bande côtière, sur une zone d'environ 1 300 ha, généralement à l'intérieur de la ligne de sonde des 30 mètres. Les principaux engins de capture utilisés sont le filet trémail et le filet maillant. Des indices d'abondance saisonnière pour les deux campagnes ont été estimés selon un modèle multiplicatif à partir de la prise globale par unité d'effort des navires (LAUREC et FONTENEAU, 1979). Les indices d'abondance globaux ainsi calculés par sous-secteur géographique, variables suivant les secteurs, sont plus élevés pour la seconde campagne d'observation (tabl. 1). De plus, la présence du récif n'a pas conduit à un déplacement de zones de pêche perceptible à l'échelle de la pêcherie.

Aucune modification importante dans la composition spécifique des captures n'a été relevée (tabl. 2), les débarquements restant constitués essentiellement d'espèces caractéristiques de substrats meubles. Les principales espèces pêchées sont des poissons plats *(Scophthalmus rhombus, Psetta maxima* et *Solea spp)* ainsi que des triglidés *(Aspitrigla cuculus* et *Eutrigla gurnardus), Sepia officinalis* et *Raja spp.* Certaines de ces espèces, comme *Scophthalmus rhombus*, apparaissent toute l'année dans les débarquements. En revanche, pour la majorité des espèces, des variations saisonnières d'abondance sont identifiées. Ainsi *Psetta maxima* apparaît essentiellement de novembre à février et *Solea spp* de mars à octobre.

En conclusion l'étude réalisée sur les récifs artificiels en Languedoc-Roussillon montre que, sans préjuger d'autres retombées potentielles et notamment de leur intérêt éventuel à plus long terme, les résultats acquis à l'échelle de temps adoptée, n'ont pas conduit à identifier un impact du récif sur la pêche professionnelle pratiquée dans les eaux littorales proches du site d'implantation.

Sous-secteur	Nord	Centre	Sud
1984-1986	12,2	7,1	14,8
1987-1988	13,2	15,1	18,7

Tabl. 1. Indices d'abondance déduits des enquêtes sur la pêche aux filets maillants.

SAISON	PRI	ETE	AUT	HIV	Moy
nord					
1984-1986	0,73	1,09	0,87	1,03	0,93
1987-1988	0,96	1,12	0,85	0,71	0,91
centre					
1984-1986	0,80	0,98	1,08	0,87	0,93
1987-1988	0,72	1,19	0,90	0,58	0,85
sud					
1984-1986	0,74	1,04	0,93	0,95	0,92
1987-1988	1,02	1,19	0,91	0,90	1,01
Moyenne					
1984-1986	0,76	1,04	0,96	0,95	
1987-1988	0,90	1,17	0,89	0,73	

Tabl. 2. Indices de diversité (Shannon) déduits des enquêtes sur la pêche aux filets maillants.

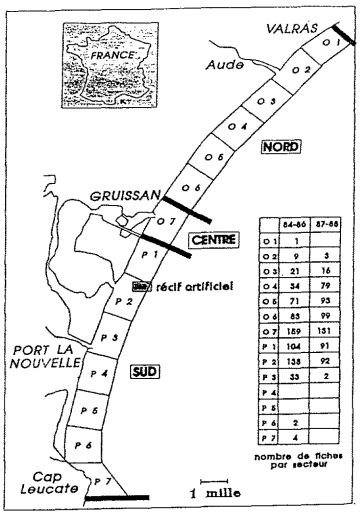

Fig. 1. Zone d'activité de la flottille de Gruissan.

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Notes on the Ecological Significance of the Fish Fauna Associated to Artificial Reefs in the Southern Tyrrhenian

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An artificial reef is to some extent a "memory" of the environment, where the benthic community is an effective storer of information and converter of energy (BOMBACE,1989). Data from the fishing yields obtained in proximity of artificial substrata have been taken into account mainly from the economic or applicative point of view, whereas their utilization as a reliable descriptor of the reef system has been neglected. In this note data, obtained from the monitoring of the fishing yields of 3 artificial reefs, are analysed in order to verify the possibility to utilize informations from catch data to asses the degree of maturity and efficiency of a manmade reef.

Methods

Three artificial reefs **(AM, TR, TE)** were deployed in the Gulf of Castellammare on a sandy bottom at distance of ca. 6 Km from each other. Further details and descriptions are reported in RIGGIO, 1990. Fishing samples were performed monthly for a year using a trammel net (height 3 m, inner mesh size 54 mm) at 6 stations (depth 18-20 m) : 3 over the reefs and 3 **(CAM, CTR, CTE)** in a nearby control site. **CAM and CTR** were located on sandy bottom at a distance of about 1 Km far from the respective artificial reefs, whereas CTE was situed at a distance of ca. 0.5Km close to *P. oceanica* meadows on a mixed bottom of hard and soft substrata. Samplings, carried out during the night for a mean fishing time of 12h, were started in each reef after 4 years from their deployment. Data from the catches were standardized to a fishnet 500 m long and the average values of the numbers and weights of the individuals in each stations were calculated in order to compare data of a site to the others. The following indexes referring to each station for both total and benthic-nektobenthic taxa were calculated: species richness of Margalef (d'), Shannon-Weaver diversity index (H'), and Pielou's evenness index (J'). Factorial Correspondence Analysis (FCA) was performed on a quantitative 6x60 station/species correlation matrix (BENZECRI, 1982) not inclusive of rare species. Axes significance was evaluated using the tables of LEBART (1975). Taxa were included in four groups according to their higher or lower affinity for the substratum and/or biocoenosis (Fig. 1).

Results

Eighty-eight taxa were identified. The highest values of d' and H' were recorded in close proximity of the reefs, whereas the values in the control sites were lower (Tab. 1). On the contrary, the evenness (J') of the control sites was nearly equal to those calculated on the reefs.

The first three axes of the FCA are significant ($P < 0.001$), accounting for as much as 90% of the total variance. The model puts into evidence a parabolic distribution of the stations along a steep gradient from soft (left side of Fig. 1) to natural hard substrata (right side of Fig. 1).

Table 1 - Community structure indexes (d' richness, H' diversity, J' evenness) calculated separately for total and benthic-nektobenthic species at each site.

AREA	AM	CAM	TR	CTR	TE	CTE
No. catch operations	16	17	19	22	11	11
d' TOTAL SPECIES	7.30	4.44	5.88	5.51	5.44	4.36
H' " "	2.44	2.14	2.91	2.72	2.76	2.44
J' " "	0.60	0.60	0.77	0.75	0.72	0.68
BENT.+NEK-BENT. SPECIES						
d' " "	6.23	3.84	5.22	4.31	5.16	3.70
H' " "	2.95	2.72	2.82	2.59	2.59	2.25
J' " "	0.77	0.82	0.77	0.77	0.68	0.65

AM,TR,TE = artificial reefs; CAM,CTR,CTE = control sites

This pattern is typical of those environmental situations heavily conditioned by a polarizing factor represented in our case by the first axis. The second axis is related to the first one by a squared relationship and represents an intensity factor. No sensible differences can be shown between each artificial reef and its control site.

Discussion

Although the trammel net is highly selective, the fauna sampled with this gear is well representative of the species composition of the nektonic community (D'ANNA *et al.*, in press).

One might expect the artificial reefs to develop a peculiar community of nektonic species, related to the nature, the shape and orientation of the artificial substrata, and more or less independent on a recruitment from neigh-bouring areas.

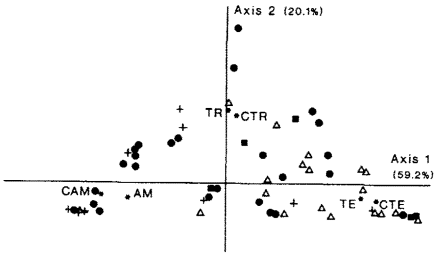

Fig. 1 - Ordination of stations and species derived from FCA

● Sandy bottom species △ Rocky bottom species
+ Pelagic species ■ Seagrass species

neighbouring areas.

On the contrary careful examination of the catch composition focuses on the reefs as individual units whose fish communities are strictly related to the natural populations living in the area. In fact, although the higher values of d' and H' in the reef areas highlight a greater variety and complexity of the environment from the point of view of biotic diversity, no valuable change in the structure of the natural population living in the area is evident.

Conclusions

Manmade reefs -as far as a critical volume is attained- should be viewed as breakups in the environmental *continuum*, that locally increase the biotic diversity by recruitment of few new taxa (D' ANNA *et al.*, in press ; BADALAMENTI *et al.*, in press), which do not alter the overall community structure. Their ultimate result is a magnification of the dominant features of the surrounding seabed, that is the major source of biological information. Detailed knowledge of preexisting communities in natural areas, often neglected in the reef plans, is the necessary prerequisite to a rational deployment of reefs. This view can give a new insight and practical directions in the promotion and future planning of artificial marine habitats.

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Coal ash for artificial reefs

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Résumé

On a étudié la colonisation des blocs de cendres de charbon provenant des centrales thermoélectriques en comparaison avec des blocs de béton. Les meilleurs resultats ont été obtenus avec les blocs de cendres qu'on pense utiliser pour la construction des récifs artificiels.

The construction of artificial habitats by sinking residual or purpose-built bodies on sea bottoms makes it necessary to ascertain whether they are compatible with marine ecosystems and in compliance with environmental protection laws of the country concerned.

ENEL - The Italian Electricity Board - has started a research program with the aim of monitoring the use of coal ash derived from its thermoelectric power plants as a component of blocks for artificial habitats whose construction is planned along the Italian coast line (SAMPAOLO and RELINI, 1991).

After preliminary laboratory tests were completed, an experimental installation was designed and constructed in the area of the Torrevaldaliga power plant (80 Km NW of Rome).

Two reef models - each made by assembling pyramids of 225 20x20x20 cm blocks - were submerged in two tanks (10x2x1,5 m) with running sea water (water flow: 3-5 cm/s).

The ash blocks were composed to 52.1 % of fly ash , 26.1 % of bottom ash, 5.2 % of hydrated lime and 16.6 % of water, while concrete blocks were made of pozzuolanic cement, sand and gravel. The main aims of this study are to obtain data about the behaviour of such materials and the interaction between the blocks and marine organisms, in particular the macrobenthos.

The observations were made at 3, 6, 9, 12, 15, 18, 21 and 24 months starting from 4 April 1990. At the moment of the examination the 6 sides of each cubes were photographed and described separately. Settlement was assessed by means of cover indices and the wet weight of the biological material scraped off each side. Subsequently the dry and ash weights were determined.

During the course of the observations the settlement on the ash blocks proved greater in quantity and better in quality than that in concrete. On ash blocks 60 species were found, compared to 50 on concrete. In particular on the ash blocks Algae together with the Serpulids are dominant components during the whole cycle of observations; on the other hand Corallinaceae and Spirorbids reach a maximum in 9-month associations, and then fall in the year long associations. Sponges, Gasteropods and Bivalves are always represented in low numbers, while Ascidians, which show a reasonable settlement on substrata immersed for 3 months, (3 M June '90), decrease to sporadic presences as the length of the period of immersion increases. Always present, however, are the colonies of encrusting Bryozoans with less marked seasonal fluctuations than the non-encrusting Bryozoans.

As already mentioned, on the concrete blocks, the associations are reduced and Algae, Corallinaceae, Serpulids and Spirorbids are the dominant components; Sponges are less represented than on the ash blocks; Gasteropods and Bivalves settle in small quantities, while the settlement of encrusting Bryozoans is greater especially on the half-year blocks. The colonies of the non-encrusting Bryozoans are particularly evident on the three-month blocks where Ascidians are missing although they are abundant on the corresponding ash substrate. The biomasses confirm the qualitative and quantitative differences expressed in the cover indices between the association which settle on the ash blocks and those on the concrete cubes.

Moreover, the increase in fouling with the increase of length of the period of immersion is much more evident and gradual for the ash blocks than for concrete, at least up to 15 months of immersion.

During the 24 months of observations, it was found that the accumulation of fouling (total wet weight), was greater on the ash-based substrata for all period of immersion except on the blocks exposed for 21 months, where there was an inversion. Furthermore, still considering the average weight values of all the blocks under examination, an increase in the accumulation of biomass was found up to 15 months, than a considerable reducion up to 21 months - a phenomenon due more to enviromental factors than to the materials under examination.

At 18 months (Sept. '91), the biomass values are lower than those found at 12 months (Mar. '91), and even the value at 21 months (Dec. '91) is similar to that found on the substrata after 3 months' immersion (June '90). Such quantitative reductions could be seen in relation to a reduction in the presence of Algae and to a Summer crisis (high temperature in August) with the consequent high mortality affecting also a proportion of the animal component.

On substrata immersed for 24 months there is a definite recovery in the biomass values; these reach values close to those obtained after the first year of study.

In conclusion, ash-based materials seem to be more suitable for the settlement of the macrobenthos. Since other studies have shown only a slight release of polluting metals and a weak bioaccumulation, these materials can be used for the construction of artificial reefs.

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Zoobenthic colonization of artificial reefs in Balearic water

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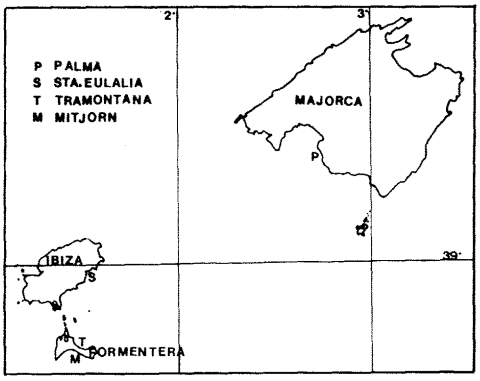
In order to stop further damage of the sea bed and to enhance its natural regeneration four artificial reefs have been established on sand and *Posidonia* meadows in the coastal area of the Balearic Islands (Table and figure).

ARTIFICIAL REEF	SITUATION	MOORING DATE	BEGINING OF THE MONITORING	BOULDERS Nº	DEPTH m
Palma (Majorca)	39º 27' 06" N 2º 42' 03" E	July-89	February-91	49	30-32
Sta. Eulalia (Ibiza)	38º 58' 03" N 1º 32' 26" E	July-90	February-91	50	25-27
Tramontana (Formentera)	38º 41' 45" N 1º 30' 00" E	July-90	May-91	50	28-30
Mitjorn (Formentera)	38º 48' 03" N 1º 27' 30" E	July-90	May-91	50	29-31



The reefs have been visited by scuba divers each four months from the date indicated in the table to February 1992. In each visit, as well as the photographic survey, four stones installed with this purpose, have been collected. In order to monitor the coverage, the stones have been studied under the microscope with a 2x2 cm mesh. A study of the reef necton and of the hydrographic conditions of the area is also carried out.

In the colonization some different stages in relation with the shape of the organisms, the zoological group they belong to and the spatial competition has been observed.

The first to colonize the substrata are small filamentous algae, hydroids, serpulid polichetes and bryozoans of stolonial growth. In the second stage forms with vertical growth appear, mainly hydroids and bryozoans with colonies hihger than the previous ones. In this stage small calcareous sacklike sponges begin to appear. At the same time the serpulids increase in number and size. The next stage is characterized by the appearance of laminar forms : sponges, both calcareous and demospongiae and incrusting bryozoans. In this stage a competition for space is observed and some cases of epiphytism and epizoims appear.

In relation to the four sides of the boulders, no significant differences were detected. Only in Sta. Eulalia (Ibiza) reef a slight siltation of the northside of some boulders was observed causing a difference in the population established.

It is too short a time for a definite population to be established. As the four reefs are established in nearby waters were no biogeographical differences are detected, the differences observed are due to local conditions or in the case of Palma, to the more avanced stage of the process. The sequence observed agrees with other authors as BALDUZZI *et al.*, 1986 ; RIGGIO *et al.* 1986 and RELLINI & CORMAGI, 1989. In contrast with some authors (BOMBACE, 1981; ARDIZZONE & BOMBACE, 1983 and ARDIZZONE *et al.*, 1989) the presence of mussels has not been recorded in any of the four reefs. We considere it due to the depth (RELLINI *et al.*, 1986) and to the oligotrophic conditions of the water. In fact the value of the contents of nutrients and pigments have been very low in the four reefs during all the monitoring time.

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Dégradation de matière organique dissoute et particulaire à l'interface eau-sédiment sur les marges du Golfe du Lion et du Golfe de Gascogne

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Le bilan du transfert de matière organique dissoute et particulaire à l'interface eau-sédiment est étudié expérimentalement à l'aide de composés organiques marqués au ^{14}C qui servent de traceurs des processus de dégradation biogéochimique.

En Méditerranée, la marge NW du Golfe du Lion est incisée par de nombreux canyons, zones de transfert des flux advectifs de matière organique depuis le plateau continental adjacent jusqu'au bassin profond. Les résultats présentés sont ceux obtenus dans les canyons de Marseille, du Grand Rhône, du Petit Rhône et Lacaze-Duthiers, à 1000m. En Atlantique NE, sur la marge du Golfe de Gascogne, la zone étudiée est celle du canyon du Cap Ferret, à 2300m.

Expérimentations

L'arrivée de matière organique, à l'interface eau-sédiment est simulée par l'injection de composés marqués au ^{14}C, dans l'eau surnageante de sous-carottages effectués dans un boxcorer (type Usnel). Deux produits marqués (^{14}C) simulent l'arrivée de matières organiques labiles fortement biodégradables : à l'état dissous, de l'acide glutamique, acide aminé qui entre dans le métabolisme des organismes benthiques; tandis que des diatomées *(Navicula incerta)* simulent l'arrivée de matière organique particulaire autochtone (bloom de phytoplancton).

L'expérimentation consiste à réaliser une incubation de 6 jours en enceinte thermostatée obscure, à la température des eaux du fond (13°C en Méditerranée; 3°C en Atlantique), sous conditions oxydantes à l'interface respectées par une circulation d'air circulant au-dessus de la tranche d'eau, permettant de récupérer le $^{14}CO_2$, piégé dans de l'éthanolamine.

Résultats

Les processus d'échanges de matière organique entre l'eau surnageante et le sédiment sous-jacent sont reflétés par le bilan du ^{14}C effectué pour les trois compartiments suivants : le $^{14}CO_2$, recueilli pendant l'incubation de 6 jours, le ^{14}C dans l'eau surnageante, le ^{14}C incorporé au sédiment, en pourcent de l'activité totale injectée (tableau suivant).

Expérimentations avec de l'acide glutamique (^{14}C) : dissous

	CO_2	EAU	SEDIMENT		CO_2	EAU	SEDIMENT
Petit Rhône (llOOm, 13°C)				**Lacaze-Duthiers axe à 850m**			
Août	7,5	26,7	65,8	Octobre	11	23	76
Décembre	3,7	5,3	91				
Grand Rhône (lOOOm, 13°C)				**Lacaze-Duthiers replat à 650m**			
Mai	1,4	36,3	62,3	Septembre	14	17	69
Mars	2,5	23,5	74	Décembre	1	44	55
				Avril	0,5	21,5	78
MOYENNES	4	23	73	MOYENNES	5	27,5	67,5

Expérimentations avec des diatomées (^{14}C) : particulaire

	CO_2	EAU	SEDIMENT		CO_2	EAU	SEDIMENT
Petit Rhône (llOOm, 13°C)				**Marseille (1300m, 13°C)**			
Août	4,1	26,4	69,5	Mai	2	19	79
Décembre	1,7	31,6	66,7	Décembre	3	10	87
Grand Rhône (lOOOm, 13°C)							
Mars	3,8	29,7	66,5				
MOYENNES	3	29	68	MOYENNES	2,5	14,5	83
Cap Ferret (2300m, 3°C)							
Juillet	0,9	10,3	88,8				

Le CO_2, résulte des processus de minéralisation dûs à la respiration des organismes benthiques. En Méditerranée, la quantité de $^{14}CO_2$ émise est d'environ 5% lors de l'utilisation du composé dissous, l'acide glutamique et du même ordre de grandeur avec le composé particulaire (3 à 4%). Par contre le $^{14}CO_2$, représente moins de 1% de l'activité totale injectée à l'interface du canyon du Cap Ferret. Les variabilités saisonnières observées après injection d'acide glutamique montrent une plus forte minéralisation en été et en automne (7 à 14%), réduite en hiver (1 à 4%) et minimale au printemps (0,5 à 2%). Ces variations sont mises en relation avec des apports plus carbonés, en été et en automne,et, au contraire, très azotés au printemps.

Dans l'eau surnageante, la proportion de métabolites relargués est forte avec ces deux composés labiles (25% en moyenne, maxima à 40%) à l'interface des canyons rhodaniens et pyrénéens. A l'extérieur du système rhodanien, dans le canyon de Marseille, cette proportion chute à 14%. Cette moindre activité est mise en relation avec un taux de C org préservé à l'interface, plus élevé dans le canyon de Marseille (0,85%) que dans les canyons du Golfe du Lion (0,6%). En Atlantique, dans le canyon du Cap Ferret, à un fort taux de C org (1,3%) correspond une faible proportion de métabolites relargués dans l'eau surnageante (10%). La faible activité de dégradation à l'interface eau-sédiment est mise en relation avec la faible température de l'eau du fond, 3°C contre 13°C en Méditerranée, une population benthique inférieure (10^4 contre 10^5 bactéries viables (CFU/ml); 600 contre 800 ind/10cm² pour la méïofaune, GUIDI L. et DINET A., comm. personn.)

Grâce à la comparaison du COD dans l'eau surnageante au départ et en fin d'incubations (4h, 24h, 6 jours) de ^{14}C *Navicula incerta, il* apparaît deux types de relargage des métabolites à l'interface des canyons du Grand Rhône et du Cap Ferret. Il est mis en évidence une rapide réponse de l'interface du Grand Rhône en 4h, puis une réutilisation (minéralisation) des métabolites formés (24h) et persistance de l'activité de relargage pendant les jours suivants (6j). Par contre dans le canyon du Cap Ferret, le délai de réponse est plus long (24h) mais l'activité est forte (30,5 mg/l de COD) et semble s'arrêter rapidement (28 mg/l après 6 jours) (Tableau suivant).

CANYONS	Durée des incubations	COD initial mg/l	COD fin incubation	facteurs augmentation	%^{14}C/activité totale injectée $^{14}CO_2$	^{14}C eau	^{14}C sediment
Grand Rhône	4h	0,99	9,8	9,9	0,3	33,3	66,4
Cap Ferret	4h	1,74	2,4	1,4	0,005	9,85	90,1
Grand Rhône	24h	0,99	6,2	6	0,3	51	48,7
Cap Ferret	24h	1,74	30,5	17,5	0,034	12,3	87,7
Grand Rhône	6 jours	0,99	15,8	16	6	44	50
Cap Ferret	6 jours	1,74	28,1	16	0,94	10,3	88,8

Après six jours d'incubation, l'analyse par HPLC des acides aminés dissous dans les eaux surnageantes montre l'importance des divers cycles métaboliques utilisant le ^{14}C acide glutamique. Des taux importants d'acides α et γ amino butyrique (décarboxylation de l'acide glutamique), ont confirmé l'augmentation des processus de minéralisation en automne. La désamination des acides aminés (acide glutamique et acide aspartique) est prouvée par la présence de glutamine et d'asparagine. L'eau surnageante renferme aussi de l'arginine et de l'ornithine, couple métabolique, bon indicateur de l'activité microbienne. L'arginine entre dans la synthèse protéique, alors que l'ornithine s'accumule dans la cellule jusqu'à son catabolisme. Au printemps, la leucine, indice de synthèse protéïque bactérienne, rend compte d'une production de biomasse bactérienne dans l'eau. L'activité métabolique des métazoaires de l'interface est confirmée par la présence de taurine, produit d'excrétion. Certains auteurs font la relation entre la biomasse de la méïofaune et la quantité de taurine.

Conclusion

En Méditerranée, dans un système soumis aux apports advectifs, à une forte activité mise en évidence à l'interface, correspond une faible préservation du C org (0,6%). Lorsque l'on se place à l'extérieur du système rhodanien (canyon de Marseille) l'activité est plus faible, le C org mieux préservé (0,85%). Dans le Golfe de Gascogne, à une bonne préservation du C org (1,3%) semble correspondre une plus faible activité. L'étude de la qualité des flux de matière organique au niveau du fond permettra de préciser les mécanismes de dégradation à l'interface du canyon du Cap Ferret.

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La matière organique des dépôts superficiels de deux marges continentales : Golfe du Lion (Méditerranée NW) et Golfe de Gascogne (Atlantique NE)

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Le bilan de la matière organique présente dans les dépôts superficiels reflète pour une part le fonctionnement de l'écosystème benthique. Cette étude entre dans le cadre plus global des transferts de matières sur les marges continentales, objectif du programme ECOMARGE (France JGOFS/PFO). Dans ce programme à l'appréciation des flux de matière dans la colonne d'eau est reliée la réponse de l'interface sédimentaire, notamment en terme de bilan du Carbone. La nature et la quantité de matière organique qui compose les dépôts superficiels permet de retracer l'histoire du transfert de cette matière organique depuis les sources, d'identifier les zones préférentielles de dépôt et l'intensité des processus biogéochimiques de sa transformation au cours de la diagénèse précoce, en relation avec la réponse du compartiment benthique.

Dans une première phase, le programme ECOMARGE, a retracé le fonctionnement de la marge continentale du Golfe du Lion (Méditerranée NW) où l'importance des phénomènes d'advection a été mise en évidence (MONACO *et al.*, 1990). A l'étude des flux de matières organiques particulaires près du fond ont été reliés la caractérisation de la matière organique sédimentaire, ainsi que le bilan entre les apports, l'accumulation et la minéralisation du carbone, sur la pente continentale du Golfe du Lion (BUSCAIL *et al.*, 1990; BUSCAIL et GADEL, 1991). De façon à poursuivre l'évaluation de la contribution des transferts de flux de carbone vers l'océan profond, la marge du Golfe de Gascogne a été choisie pour la deuxième phase du programme ECOMARGE (opération ECOFER). L'étude est focalisée dans la région du Canyon du Cap Ferret, par comparaison avec les nombreux canyons qui entaillent la pente du Golfe du Lion et chenalisent les apports.

Une similitude apparaît dans la distribution du C org à la surface des dépôts, marquée par un enrichissement localisé sur la pente moyenne de ces deux marges, située toutefois entre 500-1500 m dans le Golfe du Lion (BUSCAIL *et al.*, 1990) et 1200-2500 m dans le Golfe de Gascogne (BELIARD *et al.*, 1992).

Plus nombreuses sont les différences et particulièrement au niveau des taux de C org à l'interface qui sont deux fois plus élevés dans le Golfe de Gascogne : entre 300 et 2300 m de profondeur, dans le Golfe du Lion les taux varient de 0,3% à 1%; entre 250 et 3000 m, en Atlantique, ils varient de 0,8% à 1,6%. L'importance de la fraction carbonatée peut expliquer cette distortion. Compris entre 15 et 30% sur la pente du Golfe de Gascogne, les carbonates atteignent 30 à 45% sur la pente du Golfe du Lion (BUSCAIL, 1991).

Si une variation saisonnière des taux de matière organique et de leur qualité (plus importante et plus labile en fin d'hiver et au printemps) a été mise en évidence sur le haut de la pente pyrénéenne, dans le Golfe du Lion (BUSCAIL *et al.*, 1990), aucune variation saisonnière n'a été détectée même en échantillonnant le premier millimètre des dépôts de la zone du Cap Ferret (BELIARD *et al.*, 1992). Sur la pente du Golfe du Lion, cette variation saisonnière n'est autre que l'enregistrement de flux de matières organiques beaucoup plus importants et beaucoup plus labiles au printemps.

En Méditerranée, une bathymorphologie complexe découpe la marge en une succession Est-Ouest de canyons et d'interfluves. Excepté des taux de carbone faibles en tête de canyon dûs à une granulométrie plus grossière du sédiment (silto-vaseux, 40% < 40 µm) ailleurs pour des sédiments toujours très fins (65 à 90% < 40 µm), on note un net appauvrissement en C org des interfluves (0,4%), par comparaison avec le chenal axial des canyons (0,6%-1%). A l'inverse, sur la pente du Golfe de Gascogne, des taux de C org inférieurs à ceux des interfluves caractérisent l'axe du Canyon du Cap Ferret, dans lequel à profondeur équivalente les dépôts sont plus grossiers, résultats d'une dynamique plus active (CREMER *et al.*, 1992).

En première estimation, il semble que les processus de la diagénèse précoce de la matière organique, des dépôts des deux marges diffèrent. Sur la pente du Golfe de Gascogne la diminution du carbone organique dans les 5 à 10 premiers centimètres a été évaluée à 60% de la quantité mesurée à la surface du dépôt (BELIARD *et al.*, 1992). Alors qu'en Méditerranée, sur 13 sites bathymorphologiquement différents de la pente pyrénéenne, cette diminution n'est en moyenne que de 30% pour la partie supérieure des dépôts, définie par un même faciès de vase marron et ocre de la période fini-Holocène (4000 ans). Notons toutefois qu'une grande variabilité de la destruction du C org existe entre des sites à faible taux de sédimentation (1 cm/1000 ans) et des sites à fort taux de sédimentation (8 cm/1000 ans) pour lesquels respectivement 50% et 26% du C org sont détruits entre la surface et la base du dépôt fini-Holocène .

D'un point de vue qualitatif, on compare la disparition de 30% de la somme : Protéines, Glucides, Lipides, établie par RELEXANS *et al.*, (1992) en Atlantique, avec la diparition de 50% de la fraction hydrolysable du C org (BUSCAIL, 1991) en Méditerranée dans les 10 premiers centimètres. En Méditerranée, la diminution du C org hydrolysable en profondeur est linéairement corrélée au taux de Kérogène soluble (fractions acido soluble et matières humiques) qui lui, augmente. On peut alors penser que les dépôts du Golfe de Gascogne sont moins humifiés. Il semble qu'à l'interface du Golfe de Gascogne les processus de dégradation soient relativement moins actifs (BUSCAIL, 1992), en relation avec la faible température (3°C contre 13°C) et une population benthique moindre (10^4 contre 10^5 bactéries viables, CFU/ml et 600 contre 800 ind/10 cm^2 pour la méiofaune, GUIDI L. et DINET A. comm. pers.).

La comparaison entre la qualité de la matière organique présente près du fond sur la pente du Golfe de Gascogne (pièges à particules) et celle des dépôts superficiels correspondants, sera déterminante pour les conclusions sur le fonctionnement de l'écosystème benthique atlantique et donc une meilleure compréhension des différences observées entre les deux marges comparées.

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The distribution of ^{14}C and ^{13}C in the organic fraction of coastal sediments from Northern Adriatic Sea

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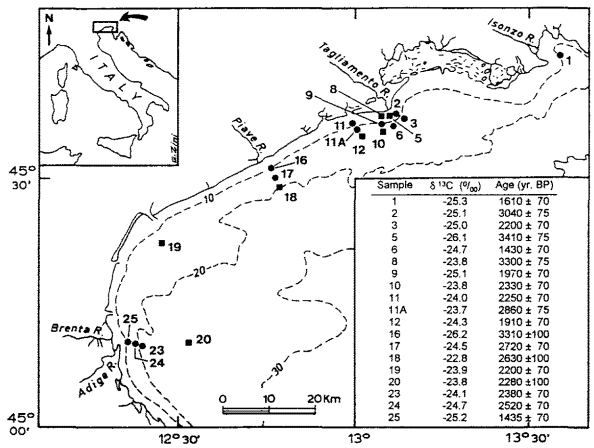
Organic matter (OM) is a key constituent and plays a major role in the transport of matter and energy into the marine environment. The fraction that becomes part of the sediment records considerable information about its origin, as well as sedimentological and geochemical processes. Besides its elemental and functional composition, other characteristics are fundamental for studying the marine environment, such as the double isotopic labelling of carbon ($^{13}C/^{12}C$ ratio and ^{14}C level) which is of particular concern for the analysis of sources, definition of the efficiency of planktonic OM regeneration and acquisition of a background knowledge for a better use of ^{14}C as a geochronological tool. So far ^{14}C has been used for dating individual marine sediment layers to provide conventional ^{14}C ages; now, a different approach is needed to implement reliable detailed chronostratigraphy for time scales in the order of thousands of years.

To obtain further information about the fate of OM in coastal marine environments characterized by significant continental input and to measure the mean apparent age of OM in recent sediments, we sampled nineteen locations in the northern Adriatic coastal area which are significantly influenced by materials delivered by Isonzo, Tagliamento, Piave and Adige-Brenta rivers. Surficial sediments were collected by means of a grab sampler, mostly along transects perpendicular to the coast, at water depths ranging from 10 to 25m. The figure shows study area, sample distribution and general lithological information (•, mud; ■ muddy sand).



Sample	$\delta^{13}C$ (‰)	Age (yr. BP)
1	-25.3	1610 ± 70
2	-25.1	3040 ± 75
3	-25.0	2200 ± 70
5	-26.1	3410 ± 75
6	-24.7	1430 ± 70
8	-23.8	3300 ± 75
9	-25.1	1970 ± 70
10	-23.8	2330 ± 70
11	-24.0	2250 ± 70
11A	-23.7	2860 ± 75
12	-24.3	1910 ± 70
16	-26.2	3310 ±100
17	-24.5	2720 ± 70
18	-22.8	2630 ±100
19	-23.9	2200 ± 70
20	-23.8	2280 ±100
23	-24.1	2380 ± 70
24	-24.7	2520 ± 70
25	-25.2	1435 ± 70

Samples were previously hydrolyzed with hot 6N HCl to remove both carbonate fraction and mobile organic compounds. The procedure is intended to provide reliable samples for measuring $\delta^{13}C$ values and ^{14}C activities only in the carbon-bearing organics stably trapped by the sediments (CALDERONI and PETRONE, 1992). Measurements were performed using mass-spectrometry and beta-spectrometry, respectively.

The $\delta^{13}C$ values average -24.5±0.8°/oo and range from -22.8 to -26.2°/oo (vs. the PDB standard). The carbon cycle involving subaereal processes produces OM with a mean $\delta^{13}C$ of -26°/oo while according to FAGANELI *et al.*, (1990) riverine OM is characterized by a mean $\delta^{13}C$ value of -28°/oo. On the contrary, marine processes produce OM with a mean $\delta^{13}C$ of -21°/oo. Therefore, the $\delta^{13}C$ values point out that OM is mainly supplied from the continental environment and this conclusion is in good agreement with the report by FAGANELI *et al.*, (1990) for the whole Adriatic Sea. The slight ^{12}C-depletion shown by most samples, compared to the $^{13}C/^{12}C$ ratio of the primitive continental OM, can be accounted for by selective loss due to early diagenesis, and/or by mixing with OM produced in the water column. In particular the latter process is supposed to have significantly affected samples with $\delta^{13}C$ values heavier than -24°/oo since most of the OM from the continent is generally produced through leaching of soil humic matter whose $\delta^{13}C$ never drops below -24°/oo The heaviest $\delta^{13}C$ values are found in offshore sandy samples, where marine OM could have contributed more significantly than continental sources (e.g., samples 18 and 20). On the other hand, the more negative $\delta^{13}C$ values were measured in samples from locations close to the river mouths (e.g., samples 2, 5, and 8).

All the OM samples were found significantly ^{14}C-depleted, compared to the modern carbon. The extent of depletion, in terms of $\Delta^{14}C$ (STUIVER and POLACH, 1977), ranges from -167.9±7.5 to -349.3±6.0°/oo corresponding to "mean apparent ages" of 1430±70 and 3410±75yr. BP, respectively. The oldest ages for OM were measured nearshore, in front of Tagliamento and Piave rivers, at water depths shallower than 10m. The youngest OM was found at depths of 10-15m in the prodelta areas of Tagliamento, Piave, and Adige rivers where sediment accumulation is relatively high. Samples farther offshore, with a significant marine component, show intermediate ages.

Carbon isotope data suggest the occurrence of three different types of OM : 1) aged OM from continental sources, 2) OM of direct continental origin, and 3) OM with a significant marine component and intermediate age. The first type, probably influenced by the reworking of old continental sediments, mostly occurs in front of the mouths of Piave and Tagliamento rivers. The area of the Tagliamento river mouth is actually affected by coastal erosion, as described by BRAMBATI (1970).

A further discussion of these data needs to be focused on the calculation of the OM contribution from each source and on their significance in studying the environmental dynamics of this coastal area.

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Sources and fluxes of suspended particulate matter in shallow coastal waters (Gulf of Trieste, Northern Adriatic) A. particulate organic matter

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Organic matter in coastal recent sediments is derived from organic matter synthetized by marine organisms (mostly phytoplankton) and that from terrigenous origin, and successively transported to the sea floor as sedimented particulate organic matter (POM), leading to the sedimentary organic matter with different composition to that in the sea surface. A striking characteristic of shallow coastal areas is that the euphotic zone is present down to the sea bottom and hence the production and degradation of POM occurs simultaneously. Macroaggregates or marine snow are frequent phenomenon in the northern Adriatic during summer and may represent the major role in the downward flux. The aim of the present work was to study the origin and temporal variation of chemical composition of sedimented POM in the S part of the Gulf of Trieste in 1991 using traps deployed at depths of 10 and 20 m. Special attention was payed to the sedimentation of macroaggregates in summer of 1991.

The annual variation pattern, depicted in Fig. 1, of particulate carbohydrate sedimentation rates showed the highest values in the mid of August at the depth of 10 m and also at the end of August at the depth of 20 m due to the slower sedimentation rate of macroaggregates in the stratified water column since the macroaggregates are prevalently composed of carbohydrates. A different pattern was observed for particulate protein sedimentation rates, more in phase with sedimented phytoplankton blooms (from chlorophyll a values), showing the highest values during the May, August and October blooms (Fig. 1). The indication of the origin of sedimented POC, estimated by $\delta^{13}C$-POC values (Fig. 1), showed the sedimented POC of purely phytoplanktonic origin ($\delta^{13}C$-POC <20‰) at the depth of 10 m in August in the period of the highest sedimentation rates of macroaggregates of diatomaceous origin. The lowest $\delta^{13}C$ values of sedimented POC observed in June indicated the influence of the terrigenous POC sedimentation originated from enhanced local river (especially Isonzo) discharges. The $\delta^{13}C$-POC variations in deeper trap in the period August-September was, on the other hand, more the consequence of surficial sedimentary organic carbon resuspension, having $\delta^{13}C$ values -22.4‰. Resuspension is an important contributor to the bottom layer sedimentation especially in the period of sea water density stratification (June-October, Fig. 1).

In conclusion, the sedimentation of POM in the central part of the Gulf of Trieste in 1991 was determined by the late spring new phytoplanktonic production and allohtonous riverine input, summer sea water density stratification and bottom sediment resuspension and, in lesser extent, the autumn phytoplanktonic regenerated bloom.

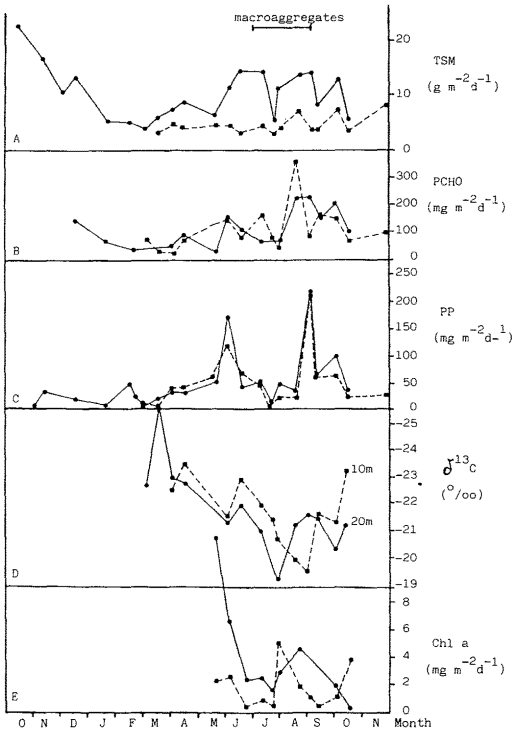

Fig. 1. Sedimentation rate of total suspended matter (TSM, A), particulate carbohydrates (PCHO, B), particulate proteins (PP, C), ^{13}C isotopic composition of sedimented particulate organic carbon (D) and sedimentation rate of chlorophyll a (Chl a, E) at the depth of l0m and 20m at sampling point F in the Gulf of Trieste from October 1990 to November 1991. Horizontal line at top indicates occurence of macroaggregates.

Sources and fluxes of suspended particulate matter in shallow coastal waters (Gulf of Trieste, Northern Adriatic) B. Particulate heavy metals

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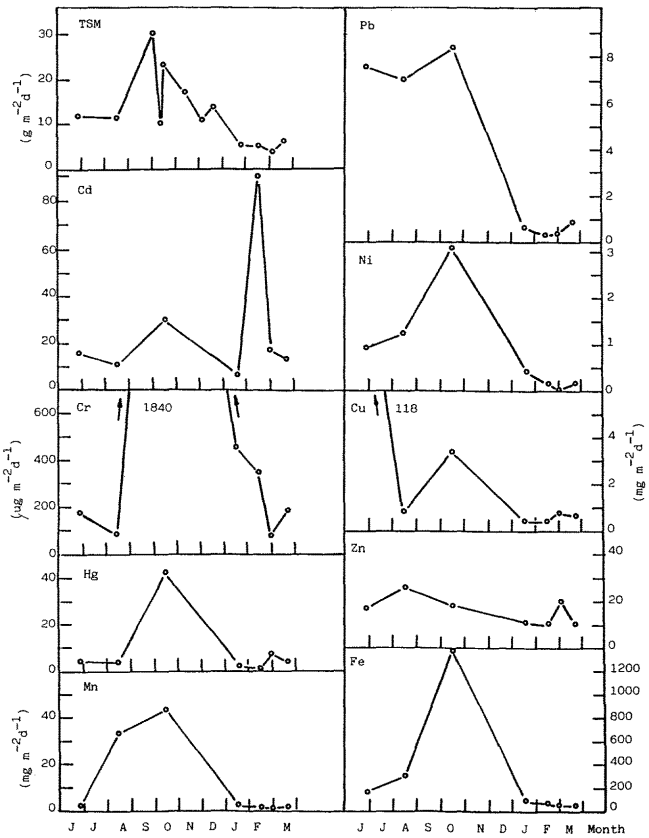
The importance of recent coastal sediments as geochemical sink for heavy metals is now widely recognized. This is also the case for the recent sediments of the Gulf of Trieste, markedly enriched in Hg and Pb contents in S-N direction mostly of riverine (river Isonzo) origin. Despite these findings, only few studies have focused the attention towards the nature of downward transport mechanism and on the nature of solid phases governing the removing of metals from the water column. The metals are bonded in or on particulate phase to be transported to sediments. Important mechanisms responsible for this association to particles, besides precipitation, coagulation and adsorption, is the interaction with the biogenic particles and these may depend strongly on the biological variations in the marine basin. Our objectives were to assess the sedimentation rates of particulate heavy metals Fe, Cu, Ni, Cd, Mn, Zn, Pb, Hg and Cr in shallow coastal marine basin, strongly perturbated by fresh water discharges, wind and sediment resuspension, and to investigate the role of different type of particles (interactions with organisms, organic and inorganic matter) in the downward flux of metals. Sedimentation rates were measured by sediment traps deployed at the depth of 20 m (approx. 1 m above the bottom) at the station in the centre of the Gulf over a year from June 1990 to April 1991 and thus covering the seasonal variations of hydrological and biological properties of the waters of the Gulf of Trieste.

Strong seasonal variations of sedimentation rates of all particulate heavy metals studied, nearly in phase with sedimentation of total suspended matter (TSM), are shown in Fig. 1. All particulate heavy metals showed high sedimentation rates in autumn period (October 1990) in parallel with the highest TSM sedimentation rates in relation to the sedimentation of autumn phytoplanktonic bloom. High particulate Cu, Pb and in lesser extent Zn and Cd sedimentation rates observed in late spring (June 1990) were due to the sedimentation of spring phytoplanktonic bloom. This demonstrated that biological surfaces may interact, besides with Cu and Zn with known physiological roles, also with other particulate metals possibly through adsorption and coagulation. The influence of resuspension, mostly occuring in the summer stratified water column, was pronounced for Pb, Zn and Mn, the latter deriving form the reoxidation of Mn^{2+}, released from sediment pore waters, to MnO_2 which is a very effective scavenger of heavy metals. Resuspension of Fe from sediments, mostly in the form of pyrite, seems to be a minor process. The role of particulate minerals, also composing surficial sediments of the Gulf of Trieste, is at present difficult to assess. The carbonates, comprising up to 67 % of sediment in the central part of the Gulf of Trieste, seem to be less important while silicates (approx. 31 % of sediments) may bond especially Pb which is known to have a high tendency of association with active surfaces.

From the present study it appears that sedimentation of biogenic matter is very important in the transport of metals to surficial sediments in the Gulf of Trieste, especially for Cu, Zn, Pb and Cd, but also for others. Resuspension also contributes to particulate heavy metal sedimentation, especially for Pb, Zn and Mn, the latter as consequence of the oxidation of pore water derived Mn^{2+} to MnO_2, scavenging other metals and transporting them to sediments.

Fig. 1. Sedimentation rate of total suspended matter (TSM) and particulate Cd, Cr, Hg, Mn, Pb, Ni, Cu, Zn and Fe at the depth of 20m at sampling point F in the Gulf of Trieste from June 1990 to April 1991.



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The sediment-water interface as studied with microsensors

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The sediment-water interface is characterized by high biological activity and steep concentration gradients of many chemical species. Ordinary chemical analysis in these steep gradients is often impossible to perform with sufficient depth resolution, and the only alternative is to use microsensors. Presently, electrochemical microsensors for O_2, pH, N_2O, dissolved sulfide, and redox potential have been used in marine research, and in fresh water environments it is furthermore possible to analyze NO_3^- and NH_4^+. Work is currently being conducted to expand the arsenal with a microsensor for dissolved inorganic carbon (CO_2 or bicarbonate). In addition to the chemical sensors fiber-optic light sensors for irradiance and scalar irradiance have been developed. Chemical microsensors with optical signal detection (optrodes) have been developed, and such optical sensors may in the future significantly expand our arsenal of chemical species which can be analyzed.

The analysis of by use of microsensors may be performed on sediment cores brought to the laboratory, but it is also possible to do in situ analysis. Simple in situ analysis at shallow water depth can be done with laboratory equipment which is brought to the field, but analysis in the deep sea requires sophisticated computerized equipment. Jens Gundersen and Bo Barker Jorgensen in our group have developed a lander which can be used down to 6000 m water depth and which can record 8 simultaneous microprofiles at 25 µm depth resolution. The microsensors which have been use until now are those for O_2, pH, and dissolved sulfide. The microsensors are identical to those used in the laboratory except that they are pressure compensated by a flexible rubber bulb filled with paraffin oil. Even in the deep sea, profiles can be recorded with extreme accuracy in terms of both concentration and spatial resolution. Among the interesting results obtained from the deep sea work is the finding that the analysis of near-interface pore water chemistry on sediment cores brought to the surface and exposed to atmospheric pressure will result in very erroneous results.

Sediments from shallow depths are exposed to daylight, and the photosynthetic activity by microorganisms within the uppermost sediment layers very much affects the pore water chemistry and thereby all microbial metabolism. We have previously shown how photosynthesis in sediments by use of microsensors can be analyzed at 0.1 mm depth resolution. The transformation and assimilation of inorganic nitrogen species were studied in various types of biofilms and sediments using ^{15}N and microsensor methods. By use of microsensors for O_2, N_2O, and NO_3^- it was possible to localize the depth horizons active in nitrification and denitrification, and it was also possible to obtain depth profiles of reaction rates. Nitrification occurred in the oxic surface layer, and in dark incubated sediments it was sometimes possible to distinguish two distinct nitrification maxima where the upper one located near the sediment surface was based on NH_4^+ from the waterphase and the lower one just above the oxic-anoxic interface was based on diffusion from deeper sediment layers. Some of the formed NO_3^- diffused out of the sediment (uncoupled nitrification) whereas the rest diffused down into anoxic layers where it was denitrified (coupled nitrification-denitrification). Denitrification was always restricted to the deeper anoxic or almost anoxic layers where NO_3^- was the most favorable electron acceptor present. The denitrification zone could be extremely thin (< 100 µm) at low NO_3^- concentrations in the overlying water and at low nitrification rates, but could also be several millimeters thick at high NO_3^-. The concentration of NO_3^- in any specific layer was not limiting denitrification as long as more than ca. 10 µM NO_3^- was present. Photosynthetic biofilms exhibited pronounced diurnal cycles in assimilation of NO_3^-, nitrification, and denitrification. Denitrification in the photic zone stopped when the sediment was illuminated and oxygen was produced by photosynthesis, but denitrification started immediately again after darkening and onset of anoxic conditions. A new ^{15}N isotope method, which is based on monitoring the frequency of $^{15,15}N_2$, $^{14\,15}N_2$, and $^{14\,14}N_2$ in N_2 gas evolved after adding $^{15}NO_3^-$ to the overlying water, was used to determine rates of nitrification and denitrification. Determination of total nitrification rates was only possible when also the isotope dilution in waterphase NO_3^- was monitored. This new isotope technique has for the first time enabled us to do determinations of nitrification and denitrification (including coupled nitrification-denitrification) in all types of biofilms and sediments without the addition of artifact-creating artificial inhibitors of metabolic processes. Investigations of a thick photosynthetic biofilm showed that coupled nitrification-denitrification was two times higher during illumination than during darkness due to better oxygen conditions for nitrification. Denitrification based on NO_3^- in the overlying water was reduced to about half during illumination due to the longer diffusion path to the denitrifying anoxic layers. Assimilation by the microflora was high in the light and remained high for many hours after darkening. This high rate of dark NO_3^- assimilation has previously erroneously been interpreted as dissimilatory reduction to NH_4^+ as mediated by strictly anaerobic bacteria.

Inventaire global de la Radioactivité de la mer Méditerranée
Programme GIRMED Etat d'Avancement 1992

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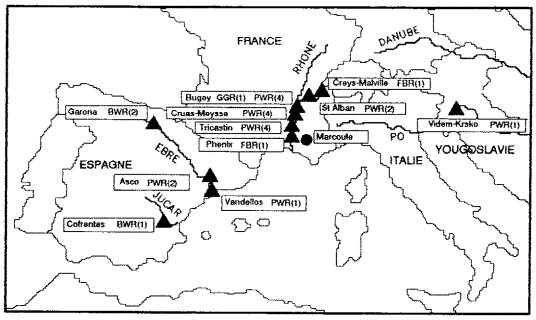
Lors de la réunion du Comité de Radioactivité Marine durant le Congrès Assemblée plénière de la CIESM à Athènes (1988) il a été décidé de promouvoir un programme sur le thème : Inventaire Global de la Radioactivité de la Mer Méditerranée (Mer Noire et détroit de Gibraltar y compris) ayant pour sigle GIRMED. Un tel programme est apparu essentiel pour répondre aux recommandations de la Convention de Barcelone pour la protection de la mer Méditerranée contre la pollution chronique ainsi que pour l'évaluation des conséquences d'une éventuelle contamination accidentelle de l'environnement marin comme ce fut le cas après l'accident de Tchernobyl.

Les principaux objectifs de GIRMED sont :

- l'intercalibration des mesures réalisées dans les laboratoires impliqués dans des programmes nationaux de surveillance radiologique,
- la cartographie spatio-temporelle des niveaux de radioactivité des principaux radio éléments artificiels dans l'eau, les sédiments et les organismes marins,
- la sélection de bioindicateurs représentatifs des niveaux de radioactivité,
- l'étude des transferts des radioéléments aux populations humaines via des composantes marines, et
- l'évaluation des coefficients de partage entre l'eau, les sédiments et les organismes marins.

Ce projet repose sur la collaboration de 15 laboratoires de 8 pays méditerranéens. De 1988 à 1992 ces laboratoires ont participé à un programme d'assurance qualité de leur mesures par l'intermédiaire d'exercices d'intercalibration. En parallèle l'inventaire des sources de rejets de radioéléments dans l'environnement marin méditerranéen a été réalisé et une base de données des mesures réalisées dans l'environnement a été mise en place. La deuxième phase conduira à l'estimation des doses pour les populations concernées par les sources de radioactivité en Méditerranée.



Centrales nucléaires (▲) et centre de retraitement (●) au 1/1/91 (bassin occidental).

EAU DE MER

Pays	Lieu	Date	Alp	Ru	Cs	Ag	Sb	Ce
FRANCE	côtes	4/86 à 9/87		X	X		X	
MONACO	côtes	5/86 à 6/86		X	X			X
ROUMANIE	Estuaire Danube côtes	10/87 5/86 à 7/90			X X			

SEDIMENT MARIN

Pays	Lieu	Date	Alp	Ru	Cs	Ag	Sb	Ce
FRANCE	côtes	11/86 à 3/91	X	X	X	X	X	X
MONACO	Cannes	2/87			X			
GRECE	Milos	12/86	X		X			
ROUMANIE	côtes	5/86 à 11/90	X		X			
TURQUIE	Akkuyu	6/89			X			

ALGUES

Pays	Lieu	Date	Alp	Ru	Cs	Ag	Sb	Ce
TURQUIE	Noire	7/86 à 1/89		X	X			
ROUMANIE	côtes	10/86 à 7/90	X	X	X	X		X
FRANCE	côtes	6/86 à 9/87		X	X	X	X	X
MONACO	côtes	1/86 à 2/87		X	X	X		
GRECE	Milos	12/86	X		X			
ROUMANIE	côtes	7/90	X		X			
TURQUIE	Akkuyu Noire	6/89 7/86 à 6/89			X X			

POSIDONIE

Pays	Lieu	Date	Alp	Ru	Cs	Ag	Sb	Ce
FRANCE	côtes	1/86 à 6/91		X	X	X	X	X
GRECE	Milos	12/86	X		X			

MATIERE EN SUSPENSION

Pays	Lieu	Date	Alp	Ru	Cs	Ag	Sb	Ce
FRANCE	rhône	9 à 3/87		X	X	X		
MONACO	Monaco offsh	4/86 à 6/86	X	X	X			X
ITALIE	La Spezia	7/86		X	X			

MOLLUSQUES BIVALVES

Pays	Lieu	Date	Alp	Ru	Cs	Ag	Sb	Ce
ROUMANIE	côtes	6/87 à 6/89	X	X	X			
FRANCE	côtes	1/83 à 9/91	X	X	X	X	X	X
MONACO	côtes	5/86 12/86		X	X	X	X	X
ROUMANIE	côtes	8/86 à 5/90	X	X	X			X
TURQUIE	Bosphore Noire	5/86 à 2/87 2/87 à 2/88		X	X X	X		

POISSONS

Pays	Lieu	Date	Alp	Ru	Cs	Ag	Sb	Ce
FRANCE	Thau Beauduc Nice	3/86 à 9/88 2/86 à 8/88 6/86 à 9/91		X X X	X X X	X X X	X X X	X X X
TURQUIE	Marmara Noire Bosphore	5/86 à 1/87 12/86 1/87 5/86		X X	X X X			
GRECE	Milos	12/86	X		X			
ROUMANIE	Constanta	6/87 à 6/89			X			

Etat de la base de données GIRMED. Classement par type d'échantillons et pays pour la période 1986-1991. Alp : émetteurs alpha soit $^{239,240}Pu$, ^{238}Pu, ^{241}Am, ^{226}Ra, ^{228}Ra, ^{232}Th; Ru: ^{103}Ru et ^{106}Ru; Cs : ^{134}Cs et ^{137}Cs; Ag : ^{110m}Ag; Sb : ^{125}Sb; Ce : ^{141}Ce et ^{144}Ce; les données sur les Polychètes Nellina ne figurent pas dans ce tableau.

Natural Gamma-emmiters in the Marine Environment Aegean and Ionian Sea - Greece

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The natural radioactivity regime in the Aegean and Ionian Sea (Greece) is summarised with respect to marine abiotic material and biota. The terrigenous actinides ^{238}U, ^{226}Ra, ^{232}Th, etc., as well as ^{40}K are considered as major contributors to the background gamma-radiation in the marine ecosystems, since artificial gamma-emitters comprise a minor fraction to the total mass of radionuclides in the Aegean and Ionian Sea (FLOROU *et al.*, 1990). The dispersion of the natural radioactivity in the different environmental materials examined is described as follows (see also Fig. 1):

Sea water

From the derived results it is noteworthy that ^{226}Ra presents elevated concentrations if compared with other Mediterranean regions (BOJANOVSKI *et al.*, 1982), while the activities of the actinides in sea water seem to follow the pattern $^{238}U > ^{228}Ra = ^{226}Ra > ^{228}Th \geq ^{232}Th$.

Sediment

The observed values in sediments from a wide network around the Greek peninsula and the Aegean Archipelagos vary greatly. The geological origin of the region considered has an apparent influence on the measured concentrations. Thus the areas of volcanic origin show elevated activities either of actinides and potassium-40. Concerning the actinides, the general pattern for sediments is $^{232}Th = ^{228}Ra > ^{238}U = ^{226}Ra$.

Algae

Algae in general show a selective bioaccumulation of ^{234}Th besides that of ^{40}K. The general pattern of activities concerning the three major groups is:

^{234}Th:	*brown algae 2 red algae >> green algae*
^{228}Th and ^{40}K:	*brown algae > red algae = green algae*

while the concentrations follow the trend $^{234}Th = ^{40}K >> ^{228}Th = ^{228}Ra$. The much higher concentrations of ^{234}Th compared with those of ^{223}Th can be explained by the build up of the supporting parent ^{238}U, which shows higher concentrations in sea water than either ^{228}Th and its precursor ^{228}Ra. In this case one must take into account the bioavailability of the different chemical forms of Th in sea water.

Sea plant

The distribution of the detected actinides in the various parts of *Posidonia oceanica* seems to follow the general pattern: *juuenile (leaves) = shoot > adult leaves*. Concerning the detected nuclides, ^{223}Ra and ^{223}Th show higher specific activities than ^{226}Ra. As the plant has a close relation with the sea bed, this can be explained by the pattern observed in sediments mentioned above, taking also into account the selective bioaccumulation of the more bioavailable chemical forms of the radionuclides considered.

Zooplancton

Thorium is selectively bioaccumulated by zooplankton as can be concluded not only from the higher concentrations of ^{234}Th and ^{228}Th in comparison with ^{226}Ra and ^{223}Ra, but also from the fact that the activity of ^{228}Th has not grown in from its precursor ^{228}Ra since it shows minor activities. Nevertheless, it is interesting that zooplancton shows higher concentrations of Th and Ra isotopes in general, if compared with algae, sea plant, benthic crustacea and fish.

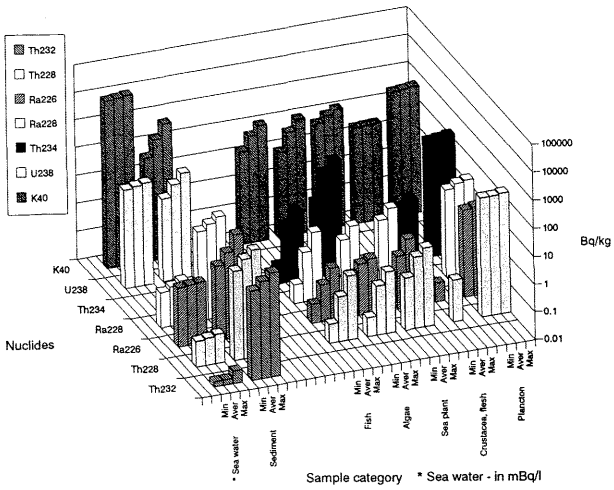
Benthic crustacea

Benthic crustacea bioaccumulate the isotopes of Th in exoskeleton rather than in flesh where ^{40}K shows the higher concentrations. The concentrations of Ra are in the same range for both tissues. In comparison with the other taxa considered, the benthic crustacea measured show the highest concentrations of 40K and the lowest concentrations of the detected actinides.

Fish

Concerning the fish of different habitats one notes that pelagic fish show higher concentrations of Th than those in demersal species. Sediment also does not seem to affect the concentrations of actinides in the plaice (*Arnoglossus laterna*) which, by eating benthic organisms, ingests the sediment adhering to them.

Fig. 1.- Natural radioactivity in marine abiotic material and biota from Aegean and Ionian Sea (Greece). Results of ERL measurements during the period 1984-1990.



This study is based on the data derived from the monitoring program of the ERL in connection with the GIRMED activities.

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The Radiological Exposure of the EC Population from Radioactivity in the Mediterranean Sea Project MARINA-MED

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The Commission of the European Communities has started a project called MARINA-MED to study the radiological exposure of the population of the European community from radioactivity in Mediterranean waters.

At this aim a working party has been set up, firstly to prepare a review of the disposal of liquid radioactive effluents directly or indirectly into the Mediterranean sea, secondly to develop a more detailed model of dispersion in the Mediterranean sea based on the work carried out for project MARINA on North European waters, thirdly to evaluate the quantities, distribution and end-uses of marine products, and finally to assess the exposure of public.

To achieve these goals four subgroups have been established, covering respectively :
- sources of radioactivity in the Mediterranean sea;
- environmental measurements and critical group dose assessments;
- quantities and utilization of marine products;
- collective dose assessment.

The following sources of radioactivity will be taken into account :
- discharges from all civil nuclear sites up to the end of 1990 ;
- fallout from weapons testing ;
- natural radionuclides ;
- Chernobyl deposition.

Regarding environmental measurements all available monitoring data will be collected. These data will also serve top test the revised Mediterranean marine dispersion model.

As regard the survey of the quantities and utilization of marine products, consideration shall be given to where the products originate, where they go and what fraction is consumed in individual Member States. From these data an assessment of individual doses to critical groups of the population will be made.

Finally a collective dose assessment will be made for the Member States.

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Data base for radionuclides in the north-western Black Sea

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A data base has been developed to include the results of a monitoring programme performed beginning with 1984 by the Romanian Marine Research Institute (RMRI) and the Environmental Radioactivity Laboratory (ERL) of the Institute of Environmental Research and Engineering (formerly affiliated to the Institute of Meteorology and Hydrology).

Samples of sediment, water, macrophytes, molluscs and fish have been collected by the RMRI and prepared according to standard methodologies (IAEA, 1970). High resolution, low background gamma spectrometrical analyses have been performed on the samples at the ERL.

A dedicated software, elaborated at ERL, has been used for the development of the data base, which is implemented on IBM-PC compatible computers.

Presently the data base contains information on 600 samples collected in the area delimited by 43°44' and 45°09' N latitude, 28°35' and 30°40' E longitude. The following types of samples are included:

- shoreline (emerged) and bottom sediment, sampled up to depths of 56 m and distances of 39 Nm offshore
- surface and bottom water, sampled up to depths of 55 m and distances of 90 Nm offshore, not filtrated
- 12 species of macro-algae
- 4 species of molluscs (bivalvs and gastropods)
- 13 species of fish.

The data base contains concentrations of natural and artificial gamma emitters as well as data characterizing the samples and their environment. It also contains gamma emitting radionuclide specific activities in atmospheric deposition sampled at 2 locations on the coast.

The transfer of data to LOTUS 123 compatible files is in progress.

A similar data base is currently being developed based on a ERL project on Danube and Danube Delta radioactivity, containing also data which define the radioactivity input of the Danube into the Black Sea.

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Acknowledgement

Part of the data included in this data base has been obtained under International Atomic Energy Agency research contract no. 4805/RB.

Développement prélarvaire du Pagre *Pagrus pagrus* et du Denté *Dentex dentex* en Crète

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INTRODUCTION

P. pagrus et *D. dentex* sont deux nouvelles espèces prometteuses de l'aquaculture méditerranéenne. Mais, les bases biologiques de leur élevage sont encore très mal connues.

L'objectif de ce travail prolongement logique d'une étude antérieure sur les oeufs (KENTOURI *et al.*, 1992), est de contribuer à préciser les caractéristiques de leur développement prélarvaire.

MATERIEL ET METHODE

Les prélarves des 2 espèces proviennent de l'éclosion d'oeufs pondus spontanément entre Avril et Mai 1992, en pleine saison de ponte de ces espèces en milieu naturel, par des géniteurs captifs depuis 3 ans et ayant maturé naturellement.

Leur développement s'effectue en parallèle à la densité de 30-35 prélarves /l dans 2 bassins cylindroconiques de 500l alimentés en eau de mer filtrée avec un débit de 100l/h et une aération très légère de 10-25 ml/min fournie par des diffuseurs en tilleul. La température, la salinité et l'oxygène dissous sont respectivement de 19 ± 05 °C, 40‰, et 7.4 mg/l.

L'étude couvre toute la période prélarvaire entre l'éclosion et l'entrée dans la vie trophique. Elle est réalisée sur des échantillons de prélarves vivantes, anesthésiées au phénoxy-2-éthanol à la dose de 0.3 ml/l. Les prélèvements ont lieu toutes les 15 minutes pendant les premières 48 heures et toutes les 30 minutes ultérieurement. Les observations sont effectuées en vision zénithale et latérale avec un stéréo microscope (Olympus SZH) équipé d'un zoom et d'une caméra CCD Panasonic B.L 202 fixant chaque séquence. Les mesures sont faites par analyse d'image au moyen du logiciel de traitement "Image Pro Plus" version 1.0 de Media Cybernetic Inc. (1990-1991). Les dessins sont réalisés d'après les clichés. Les zones imprécises sont vérifiées a posteriori par réobservation sous binoculaire du matériel initial formolé.

RESULTATS

A l'éclosion, les prélarves du Pagre et du Denté sont extrêmement semblables tant sur le plan morphologique que métrique et présentent l'organisation générale primitive typique des sparidés. Elles mesurent entre 2.25 et 2.30 mm de longueur totale dont 1.19 à 1.20 mm de distance préanale. La tête est appliquée sur un vitellus gros et ovoïde de 1.13x0.56 mm dans ses 2 axes qu'elle ne dépasse pas en avant. Le globule lipidique, non pigmenté, et situé à la partie postérieure du vitellus, n'est pas en contact avec la masse musculaire. La pigmentation est constituée d'iridophores bruns (plutôt étoilés chez le Denté et plutôt punctiformes chez le Pagre sans que cette tendance ne soit générale) situés à 4 endroits du corps (anneau étoilé au quart postérieur de la queue, paire latérale en arrière des vésicules auditives, paires latérales en avant et en arrière de l'oeil, à la séparation intestin-masse musculaire), ainsi que quelques autres iridophores sur le corps et le vitellus.

Après l'éclosion, les prélarves des 2 espèces évoluent très rapidement et subissent des modifications morphologiques importantes (fig. 1 et 2). La forme générale s'affine par le jeu combiné d'une consommation totale des réserves vitellines, d'une diminution des réserves lipidiques d'environ 30% pour le Pagre et de 33% pour le Denté (valeur calculée d'après la réduction du diamètre du globule), et d'un allongement du corps presque exclusivement limité à la partie post anale (fig. 1). La tête se dégage progressivement du vitellus et le profil de la chorde, initialement légèrement sigmoïde, se linéarise à partir de 3.20 mm LT (longueur totale). La diminution des réserves lipidiques conduit à une avancée du globule lipidique vers le museau parallèlement à une accentuation de la visibilité du tube digestif coudé à l'arrière et qui s'ouvre au bord de la nageoire primordiale. Chez les 2 espèces, la pigmentation par iridophores notamment l'anneau autour de la queue s'accentue jusqu'au moment de l'ouverture de la bouche, puis il régresse progressivement au profit de la pigmentation par chromatophores noirs qui s'établitau dessus du tube digestif. La nageoire pectorale membraneuse apparait entre 3.10 et 3.15 mm LT pour le Pagre et 3.05-3.10 mm LT pour le Denté; l'oeil se pigmente et la bouche s'ouvre à 3.40 mm LT chez le Denté et 3.42 mm LT chez le Pagre, et l'opercule se forme respectivement à 3.41 et 3.51 mm LT, ce qui correspond à l'entrée dans la phase trophique.

La durée du stade prélarvaire (terminé par la première intention d'alimentation) et la longueur totale atteinte à ce moment, (77±2 heures et 3.41 mm chez le Denté contre 88±3 heures et 3.5 mm chez le Pagre), diffèrent chez les 2 espèces. Mais, exprimées en % du temps total de développement, les étapes de la morphogénèse sont assez constantes, ce qui est la preuve d'une forte homogénéité familiale. Toutefois, la différence de vitesse de résorption des réserves lipidiques entre les 2 espèces (fig 1), preuve d'une différence de métabolisme, traduit une spécificité physiologique pouvant expliquer les différences ultérieures de facilité d'élevage.

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Développement embryonnaire du Pagre *Pagrus pagrus* et du Denté *Dentex dentex* en Crète

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P. pagrus et *D. dentex* sont deux nouvelles espèces prometteuses de l'aquaculture méditerranéenne. Préalable important de leur élevage, les caractéristiques de leur développement embryonnaire sont mal connues.

L'objectif de cette étude est de contribuer à combler cette lacune.

MATERIEL ET METHODE

Les oeufs des 2 espèces sont obtenus par ponte spontanée de géniteurs maintenus en captivité depuis 3 ans et ayant maturé naturellement. Ils sont récoltés à la surverse après concentration dans un collecteur en maille à plancton, entre Avril et Mai 1992, en pleine période de ponte de chaque espèce.

Leur développement s'effectue en parallèle à la densité de 40 oeufs/l dans 2 incubateurs de 500 litres alimentés en eau de mer filtrée, renouvelée à raison de 40 % /heure. La température et la salinité sont respectivement de 18.5 ± 0.5 °C et 40 ‰.

L'étude est réalisée sur du matériel vivant prélevé toutes les 30 minutes entre la fécondation et l'éclosion. Les observations sont effectuées en vision zénithale et latérale avec un stéréo microscope (Olympus SZH) équipé d'un zoom et d'une caméra CCD Panasonic B.L 202 fixant chaque séquence. Les mesures sont faites par analyse d'image au moyen du logiciel de traitement "Image Pro Plus" version 1.0 de Media Cybernetic Inc. (1990-1991). Les dessins sont réalisés d'après les clichés. Les zones imprécises sont vérifiées *a posteriori* par réobservation sous binoculaire du matériel initial formolé.

RESULTATS

Les oeufs des 2 espèces présentent les caractères généraux de tous les sparidés (DIVANACH, 1985). Leurs caractéristiques métriques sont très voisines (Tab. 1) et leurs durées de développement, bien que différentes en valeur absolue (Tab. 1), sont similaires lorsqu'elles sont exprimées en % cumulé du temps de développement depuis la fécondation jusqu'à l'éclosion. C'est cette forme de représentation de l'âge de l'oeuf, résumée par le sigle % TD (% du temps de développement), qui sera utilisée par la suite.

Tab. 1 Caractéristiques des oeufs de *Dentex dentex* et de *Pagrus pagrus*

	Dentex dentex	*Pagrus pagrus*
Diamètre moyen de la coque (µm)	1007 ± 10	1005 ± 12
Valeurs extrêmes de diamètre (µm)	983 à 1027	980 à 1025
Diamètre de la goutte d'huile (µm)	254 ± 8	251 ± 7
Durée d'incubation à 18.5 °C (heures)	42 - 45	52 - 54

Les ovules récemment émis sont sphériques et pélagiques. Leur coque, semi rigide, présente localement des micro rides lui donnant un aspect mat. Le vitellus homogène, transparent et incolore remplit entièrement la coque et contient une seule gouttelette lipidique excentrée de couleur jaunâtre. Le cytoplasme forme une mince couche corticale autour du vitellus et est plus épaissi au pôle animal opposé à la goutte d'huile.

L'activation provoquée par la fécondation (0 % TD) modifie ces caractéristiques en moins de 10 minutes. L'éclatement des alvéoles corticaux, l'absorption d'eau et la rétraction vitelline qui en résulte, conduisent à une augmentation de diamètre d'environ 2% et à la création d'un petit espace périvitellin qui est presque invisible, sauf au pôle animal en vision latérale. Parallèlement la coque se durcit et devient lisse, la différenciation bipolaire s'amorce et le cytoplasme se concentre au pôle animal, permettant l'individualisation du germe; les oeufs deviennent hyponeustoniques.

Les oeufs, télolécithes, se divisent selon une modalité classique (oeufs méroblastiques) par segmentation partielle discoïdale qui commence vers 1,5% TD au rythme de 0.5-0.7% TD/h. Les premiers clivages sont relativement synchrones et symétriques jusqu'au stade 16, mais se désolidarisent ultérieurement, et la morula, visible vers 9-10% TD présente une segmentation anarchique. La fin de la blastulation et le début de la gastrulation ont lieu entre 18 et 22% TD.

La mise en place des feuillets fondamentaux (gastrulation) par épibolie se prolonge jusqu'à 40-45% TD. Mais les migrations cellulaires et les modifications par réarrangements axiaux qui signent le début de la neurulation par le dessin de la future tête de l'embryon commencent à être identifiables vers 28-30% TD. A la fermeture du blastopore, l'embryon couché à la partie inférieure du vitellus s'étend sur un peu moins d'un demi grand cercle et est incliné d'environ 45° tête en bas par rapport à l'assiette de l'oeuf. A ce stade, l'organogénèse est peu avancée et touche la tête avec l'ébauche des yeux non pigmentés et des vésicules auditives, puis le tronc avec un début de métamérisation centrale et une dizaine de somites et enfin le bourgeon caudal sur lequel se développe la vésicule de Kupffer.

Lorsque l'embryon fait environ 2/3 d'un méridien, vers 50% TD, la vésicule de Kupffer disparait, le bourgeon caudal se dégage du vitellus et pousse (généralement en crochet), les otolithes sont visibles, les premières traces de pigmentation, parfois provisoires, apparaissent sous forme d'iridophores punctiformes bruns sur la partie dorsale de la tête et sur le bourgeon caudal à l'endroit où il se dégage du vitellus.

A une taille proche de 3/4 d'un méridien, vers 78-82% TD, le coeur de l'embryon commence à battre par intermittence, la pigmentation est bien établie : anneau d'iridophores bruns à bord net mais non régulier autour du bourgeon caudal, paires latérales d'iridophores punctiformes symétriques à l'avant et à l'arrière de l'oeil, iridophores bruns jaune ou chromatophores noirs décalés sur le reste du corps et le vitellus. L'implantation de cette pigmentation est encore trop commune à beaucoup d'espèces pour être considérée comme spécifique. Le globule lipidique n'est pas pigmenté.

A une taille voisine d'un méridien, vers 90-95% TD, l'embryon commence à bouger, le coeur bat de façon régulière, la nageoire primordiale est bien développée, le cristallin de l'oeil est visible, la corde dorsale forme une ligne nette de la tête à l'extrémité de la queue. Dans l'étape qui précède l'éclosion, vers 95-98% TD, l'embryon bouge assez régulièrement et tourne dans la coque devenue légèrement trop grande du fait de la consommation des réserves vitellines.

Le processus de l'éclosion à 100% TD est identique à celui de beaucoup de poissons et est assez synchrone pour la majorité de la population. Le chorion dissout localement par une enzyme sécrétée par la tête du poisson se fragilise. Puis à l'occasion de 2 ou 3 séries de contorsions espacées de quelques minutes pendant lesquelles la queue appuie fortement sur le chorion, la prélarve sort progressivement la tête, la moitié du corps, puis se dégage complètement et rentre en position de repos.

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Gulf of Cadiz and the Alboran Sea : A Target for Post-Messinian Paleoceanography and Paleoclimatology Study

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The post-Messinian paleogeography of the Atlantic-Mediterranean area is characterized by a single communication gateway between both oceans, through the Gibraltar Strait. During pre-Messinian times however a double communication existed through the Riffean and Betic gateways.

The Alboran Sea (western Mediterranean) is connected with the Atlantic Ocean through a narrow passage, the Strait of Gibraltar, which opened in the Pliocene. During a major part of the Pliocene, Atlantic-Mediterranean water exchange was of estuarine type, with a deep Atlantic water inflow below a less dense Mediterranean outflow (THUNELL *et al.*, 1987). During the Quaternary the water exchange was mainly of antiestuarine type with net outflow of a deep layer of more saline Mediterranean water, a situation that remains until present (THUNELL *et al.*, 1987; MILLOT, 1987). Although the mechanism for changing from an estuarine to an antiestuarine exchange pattern is not well understood, it seems to have occurred some time near the Plio-Pleistocene boundary. Several reversals in the exchange pattern have been recognized during the Quaternary, leading to the development of organic-rich layers in the Mediterranean which are also affected by important climatic and eustatic changes during this time (THUNELL *et al.*, 1984; EMEIS *et al.*, 1991).

In the Gulf of Cadiz the Mediterranean outflow through the Gibraltar Strait is responsible for an upper slope boundary current that flows northward along the Iberian margin (GARDNER and KIDD, 1987). As a result of the Mediterranean outflow, contourite deposits have been developed at the Gulf of Cadiz continental slope since the early Pliocene (GONTHIER *et al.*, 1984). The alternation of contourite deposits and sediment drapes in the upper part of the Pliocene to Quaternary sequence indicates fluctuations in the Mediterranean outflow (NELSON *et al.*, 1992). The development of these deposits has to be related to the eustatic sea level changes as well as to the pattern of the Atlantic-Mediterranean water exchange through the Gibraltar Strait.

Key Scientific Questions

The key scientific objectives related to the above issues are the following:

* to evaluate the impact of the Atlantic-Mediterranean water exchange pattern since the Pliocene to present under different climatic conditions in the sedimentary record.
* to assist in the understanding of the mechanism that controls climate change.
* to validate established climatic models for the glacial-interglacial cycles in the Quaternary.

Scientific Relevance

The proposed areas are of particular importance because:

* the Strait of Gibraltar provided the communication gate for Atlantic-Mediterranean exchange from the Pliocene to present.
* the Alboran Sea is an important source of saline waters to the Global Ocean.
* the Atlantic-Mediterranean water exchange pattern has fluctuated throughout the Plio-Quaternary with a subsequent influence on the Mediterranean and Global Ocean History.

All of these scientific targets require the penetration of the sea floor and the recovery of continuous undisturbed sediment cores. We propose at least two reference sediment cores using the techniques of the Ocean Drilling Program the Alboran Sea and the deep-sea zone of the Gulf of Cadiz. The study of these areas is required to understand the communication between and the fluctuations in exchange of the Atlantic-Mediterranean system, as well as the climatic changes that occurred during Plio-Quaternary times. It will also allow for comparison with the Neogene record, when the Riffean and Betic gateways existed.

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The Problem : need for a biomagnetostratigraphic reference section representing a marine miocene mid-latitude environment. The Answer : re-occupation of DSDP Site 372 (Balearic Basin)

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The correlation of biostratigraphic events to the geomagnetic polarity scale forms a basic element in most attempts to develop a Cenozoic geochronology. It suffices to combine biostratigraphic and magnetostratigraphic data within the framework of a single time scale in order to establish a reliable chronology for deep-sea sediment sequences. The degree of accuracy of such chronology depends largerly on the proper identification of the reversal sequences. Uncertainties arise chiefly from the difficulty of retrieving complete magnetostratigraphic sequences that represent long periods of time. But once adequate magnetostratigraphic sequences are established, we can use biostratigraphy as a key to unravel chronologic relationships.

The need for improved chronological control has increased vastly over the past few decades, and the continous success of modern paleoceanography is closely linked to our ability to understand chronology.

A reasonable number of deep-sea sections is now available from low and mid-latitude environments that possess adequate magnetostratigraphies, encompassing the past few million years. Thus, many Pliocene and Pleistocene biostratigraphic events are tied directly to the magnetic polarity zones. In contrast to this latest Neogene situation, it is surpsising to note that we still do not possess a single continous Miocene section with adequate magnetostratigraphy. The most problematic Miocene interval in this respect covers the interval from the basal Tortonian stage to the Upper Burdigalian stage, or between Anomaly 5 time and Anomaly 6 time in terms of the marine magnetic anomaly time scale. On a geochronometric scale, this interval represents the time span between about 10 Ma and 20 Ma. Even when viewing the entire Cenozoic stratigraphic column, this particular Miocene interval is associated with some of the least precise, or least accurate, bio- and magnetostratigraphic correlations. The Miocene correlation problem presumably results from several interacting phenomena, such as :

(a) short duration of the polarity zones,
(b) existence of large scale hiatuses and unconformities,
(c) low sedimentation rates and loss of biostratigraphic resolution because of dissolution problems (deposition close or below the lysocline).

The solution to the stratigraphic problem lies in the retrieval of continously deposited sedimentary successions representing primarily the Burdigalian-Langhian-Serravallian-Tortonian stages, from a deep-sea depositional setting. These sections should display sedimentation rates in excess of 10 cm/1000 years in order to avoid the pitfalls that resolution problems may cause.

DSDP Site 372, drilled in 1975 in the western Balearic Basin (HSU, MONTADERT *et al.*, 1978) has the potential to solve the problems outlined above.

The succession (Fig. 1) is continuous underneath a major gap related to a Messinian erosional surface.

Nannofossil zones NN1 to NN7 and foraminiferal zones N5 to N1 have been identified (BIZON, CITA & MULLER, 1978). This expanded preMessinian hemipelagic section is 700 m thick, and is potentially well suited for magnetostratigraphic studies.

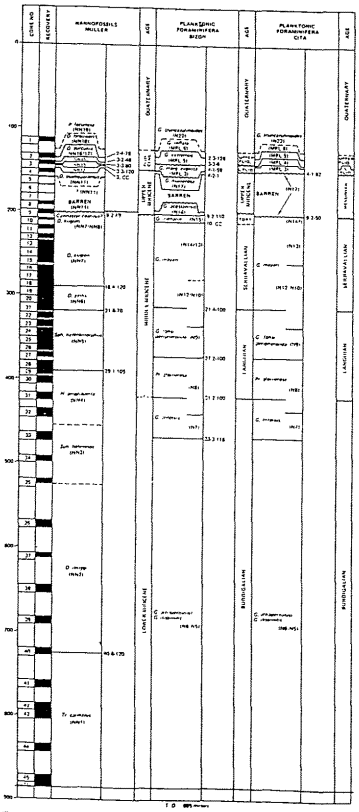

Figure 1 . *Relative planktonic microfossil zonations, Site 372.*

No continuous coring was accomplished, and no magnetostratigraphic investigations were carried out. With deeper penetration, even the Oligocene/Miocene boundary could be reached, since the initial rifting of the Balearic Basin should have started in the late Oligocene.

This mid latitude Miocene succession is very close to the typesections of the Langhian, Serravallian and Tortonian stages, originally defined in Italy, and of the Aquitanian and Burdigalian stages, defined in France. Thus, it has the advantage of offering easy correlations with the type sections (same bioprovince, similar paleoclimatic situations), but a depositional continuity that no landbased section deposited in an epicontinental marginal basin can provide.

This drilling proposal is strongly supported by the Subcommission on Neogene Stratigraphy of IUGS.

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New Data on the structure of the Sardinian Underwater Margin in the Tyrrhenian Sea

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New additional data on the structure and composition of the Sardinian margin in the Tyrrhenian Sea were obtained during the 10th leg of RN "Antares", which was carried out in the Mediterranean Sea in the summer of 1991 by the Institute of Lithosphere of the Russian Academy of Sciences in collaboration with Italian scientists from the Ferrara, Udine and Torino universities. The following conclusions could be drawn:

1. Gneisses, quarzites, schists and metabasalts dredged at the Cornalia mountain and in the southern edge of the Baroni ridge, confirm that the Sardinian margin basement is mostly composed of the Paleozoic metamorphic complex, exposed in Sardinia. Of particular interest are findings of basalts and diabases metamorphosed in the greenschist facies.

The content of minor elements (TiO_2=1.94%, K_2O=0.2%, Ni=238 ppm) and their ratios (Ti/Zr=80, Zr/Y=4.9, Zr/Nb=24, La 104/Ti=6.01) point to affinities to MORB-like tholeiites. They are somewhat similar to ophiolitic and "schistes lustres" basalts developed in Corsica and supposed to be of Late Jurassic age. This implies that the ophiolite sequence obducted upon the metamorphic basement from the west, also extends along the underwater margin of Sardinia.

2. The sedimentary cover of the Sardinian underwater margin has a maximal thickness amounting to 600m. It comprises three stratigraphic unites embracing the time interval from the Late Miocene to the Holocene and lies unconformably on the acoustic Paleozoic-Jurassic (?) basement. If the last epoch of the basement fold-nappe deformation was completed as in the Apennines, the lower pre-Messinian sedimentary complex should belong to the Tortonian. The same age for these formations was obtained by the shipboard party of ODP Leg 107 on the basis of the materials of Hole 654. The seismic profiling data suggest that initially this complex must have been continuous and that its absence in certain parts is due to pre-Messinian and later erosion.

3. The thickness of Messinian evaporites reflects differentiated block shifts, connected with rifting in the Tyrrhenian Sea in Messinian time. The absence of Messinian deposits on certain blocks may be explained either by a position higher than the level of the brines, or by later erosion. The occurrence of underwater-slumping or underwater-avalanche deposits confirms the intensity of tectonic movements during the Messinian.

4. Pliocene-Quaternary deposits unconformably overlie the older deposits up to the basement, locally adjoining them unconformably and revealing facies changes near the uplifts. This is indicative of pre-Pliocene movements along faults. Intensive movements were also recorded in Late Quaternary and in fact determined the recent structure of the margins. Salt diapirism also occurs at that time. These young movements are synchronous with the opening of the easternmost deepwater basin of the Tyrrhenian Sea - the Marsili basin.

5. A previously unknown volcano has been discovered on the southern edge of the Baroni ridge. Slightly altered basalts corresponding petrochemically to MORB tholeiites have been dredged here. It differs from the MORB-like tholeiites have been dredged here. It differs from the MORBlike tholeiites drilled in the deep part of the Tyrrhenian Sea in being enriched in incompatible trace elements (Rb=9 ppm, Ba=109 ppm, Sr=621 ppm, La 10^4/I=14.2), similar to MORB E-type.

Moreover, according to continuous seismic profiling data, a Tortonian or pre-Tortonian caldera-like structure buried under sedimentary cover is inferred to exist. The new data as well as previous ones suggest an extremely intensive tectonic mobility of the Sardinian margin under active extension from the Late Miocene to the present, i.e; during the opening of deep Tyrrhenian basin.

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Why Drill Sapropels (Again)?
An effort to study the depositional history and environmental development during the formation of Sapropels in the Mediterranean.

Edward A. BOYLE, Stephen E. CALVERT, Angelo CAMERLENGHI, Adrian CRAMP, Kay-C. EMEIS, Frederick G. PRAHL, Robert C. THUNELL and Rainer ZAHN

The discovery of multiple layers of sapropels and sapropelic sediments in the Eastern Mediterranean Sea during the Swedish Deep-Sea Expedition (KULLENBERG, 1952) marks the onset of a controversial dispute among marine geologists concerning the depositional environment responsible for their formation. In spite of considerable scientific effort and an increasing data base on their sedimentological, faunal, chemical, and isotopic characteristics, sapropels still elude simple explanations.

Opinions are divided into two broad lines of thinking: One line favors intermittent anoxia of deep waters, which would impede remineralisation of organic matter at the sediment-water interface and enhance its preservation. Anoxia could have been established by either increased fresh-water runoff due to increased monsoonal rainfall or increased runoff after melting of continental ice sheets, by inhibition of deep-water formation, or by capping the Mediterranean surface water with less saline water from the Atlantic. The other line of reasoning argues that pulses of high biological productivity in the surface waters is the key to understanding sapropel formation (PEDERSEN and CALVERT, 1990). It is well demonstrated that most of the correlative and coeval sapropel layers in the eastern Mediterranean were deposited during climatic optima in the Pleistocene glacial epoch (RYAN, 1972; THUNELL *et al.*, 1978; ROSSIGNOL-STRICK, 1984; Fig. 1). In analogy with climatically-induced changes in biological productivity during the Pleistocene in other parts of the world ocean, production and accumulation of organic carbon may have been greatly increased in response to changes in water circulation leading to upwelling of nutrient-rich waters. Both hypotheses agree that sapropels signal distinctive changes in the physical circulation and chemical environment of the Mediterranean Sea (Fig. 2), and that climate changes are the driving factor (CITA *et al.*, 1977). The discovery of sapropels throughout the entire stratigraphic succession of post-messinian marine sediments in the eastern basins of the Mediterranean and the Tyrrhenian Sea shows that the entire basin was affected by the changes, even if resulting facies variations were much less pronounced in the western basins.

A renewed effort to elucidate the responses of the carbon cycle in the Mediterranean to climatic forcing on one hand, and the relative importance of preservation and production in burial of organic carbon in the geologic record on the other hand is needed and timely: Clarification of environmental conditions in the Mediterranean during times of sapropel formation and the exact timing of environmental changes will thus have implications exceeding any regional interest and may be applicable to the entire world ocean. New tools and concepts that evolved during the last few years may aid in this clarification: A transect of piston-core drill sites targeted on hemipelagic, undisturbed sedimentary sections deposited on structural highs since the end of the Messinian and bracketing all major basins of the Mediterranean will permit to trace the physical, chemical, and biological response to external forcing in high resolution. In addition to traditional sedimentological and paleontological work, focus of post-cruise work should be on :

- high-resolution isotope analyses of foraminiferal carbonate to establish a basin-wide and detailed stratigraphy,
- statistical treatment of faunal and floral assemblages to constrain surface- and bottom-water conditions at each site through time,
- analyses of redox-sensitive chemical tracers to establish the importance of bottom-water oxygenation for sapropel deposition,
- reconstruction of biological productivity and carbon burial through organic and inorganic tracers,
- determining the temporal variations of temperature and salinity as recorded by chemical and faunal indicators through time.

Given the large carbon reservoir of the world ocean, study of boundary conditions during sapropel deposition the the Mediterranean will provide a better understanding of the mechanisms which define the architecture of the ocean s carbon reservoir. This in turn controls the atmospheric chemistry and hence Earth's climate.

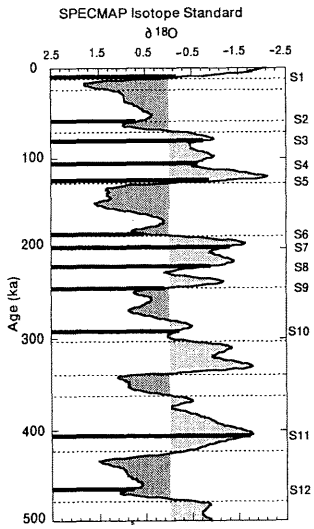

Fig. 1:
Sapropel occurrences in relation to the global record of isotope changes in planktonic foraminifers Shaded are warm and cold periods, respectively.

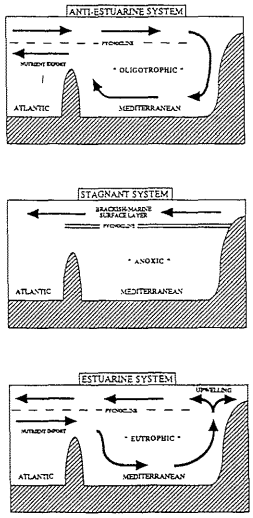

Fig. 2:
Models of possible oceanographic and chemical variability responsible for sapropel formation.

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ODP Targets on sediment deformation and post-Messinian depositional patterns of the outer deformation front of the Mediterranean Ridge accretionary complex

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A re-examination of the multichannel seismic coverage of the Mediterranean Ridge (Eastern Mediterranean) has been done motivated by growing attention to the evolution of accretionary wedges.

Although preliminary results of the extensive geophysical investigations conducted by OGS in the whole Mediterranean Sea from 1969 to 1982 have been published by the principal investigators (FINETTI and MORELLI, 1972 and 1973), most of the MCS lines of the Eastern Mediterranean (FINETTI, 1976 and 1982) are still unpublished and no definitive interpretation has been proposed in the frame of the recent identification of the Mediterranean Ridge as an accretionary prism in a collisional setting.

MCS lines crossing the outer deformation front of the ridge that extends from west to east from the Messina and Sirte abyssal plains (Ionian Sea) to the Herodotus abyssal plain (Levantine Sea) reveal two different styles of initial deformation of the sedimentary sequence entering the subduction zone: 1) to the Southwest, where the deformation front is orthogonal to the direction of plate convergence, a thin post-Messinian sedimentary sequence (up to 450 ms TWT) only slightly disturbed by initial salt-diapirism is coherently and abruptly uplifted. A re-processed version of line MS-33, which includes migration, shows evidence of seaward vergent thrusting and back-thrusting. 2) to the Southeast, where the ridge is oriented at a small angle with the direction of plate convergence and left lateral strike-slip movement occurs in the Pliny and Strabo branches of the Hellenic Trench, a thick post-Messinian sedimentary sequence (over 1800 ms TWT) is gently deformed by seaward vergent folding and reverse faulting with formation of piggyback sedimentary basins (over 2400 ms TWT). Salt deformation and initial salt diapirism in the core of anticlines of the SE margin of the Mediterranean Ridge show typical characteristics of other salt-bearing fold and thrust belts.

In the Levantine portion of the Mediterranean Ridge, the following depositional patterns can be identified in the post-Messinian sequence:

1) The overall Plio-Quaternary sediment thickness decreases from north to south across the deformation front.

2) The internal pattern of the uppermost Messinian and/or lowermost PlioQuaternary units (i.e. post evaporites) indicates a southward sediment progradation directly overlying the top-of-the-evaporites Messinian horizon. Northward sediment progradation occurs in the overlying remaining Plio-Quaternary sequence.

3) The sediment thickness of the Plio-Quaternary sequence does not increase significantly as the Nile Cone is approached from the Herodotus abyssal plain.

Drilling targets:

On the Sirte deformation front: A transect of at least three shallow holes in the post-Messinian sequence across the deformation front would allow the estimation of rates of uplift and outward growth of the outer edge of the western Mediterranean Ridge. Timing of the change of sedimentation pattern (from basinal to hemipelagic) will be provided by the well tested high resolution litho- and bio-stratigraphy of the Pleistocene of the Eastern Mediterranean. Pliocene high resolution stratigraphy is to be refined through drilling a reference site on a all-pelagic Plio-Quaternary site.

On the Herodotus deformation front: A single hole located on a buried anticline crest through a condensed Post-Messinian section would allow to tie the main unconformities, time the rate of folding, and investigate the nature of the northward versus southward sediment progradation. A working hypothesis is that the southward propagating unit overlying the evaporitic sequence may represent a sediment provenance from Paratethys (i.e. Black Sea "Lago Mare") in latest Messinian (post evaporites) time soon replaced by a Nile derived northward prograding sediment provenance.

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High Resolution late neogene Paleoceanography and climatic variability in a critical area of the Central Mediterranean

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A drilling proposal aiming at a reconstruction of the depositional history and environmental development during the deposition of sapropels in the eastern Mediterranean has recently been submitted (ZAHN *et al.*, 1991). To assist in this effort and to add a wider geological perspective, we propose here a location in the Sicily Channel that is ideally suited to investigate the paleocirculation of the Mediterranean since the Pliocene. The Sicily channel is an area critical for the connections among the western basins and the deeper, more distal eastern basins.

Current reversals that may have changed the present-day nutrient-desert to a highly productive nutrient trap are believed to have happened throughout the Plio-Quaternary. They must be recorded at the bottle neck of circulation, the sill in the Sicily Strait.

Water depth at the proposed drillsite is approximately 600 m. Coring should be continuous (APC and XCB) to the base of the Pliocene (top of the Messinian or Horizon M) that has an estimated depth of approximately 500 m

This expanded hemipelagic section lies some 30 km seaward of the classic exposure of Capo Rossello in Sicily, where the early Pliocene Zanclean stage has been defined (CITA & GARTNER, 1973), the Miocene/Pliocene boundary type section has been proposed (CITA, 1975) and the Rossellian superstage as well (CITA & DECIMA, 1975). Further detailed biostratigraphic, cyclostratigraphic and magnetostratigraphic investigations confirmed the excellent continuity and resolution of the land section, so that the "Rossello composite" is now considered a Mediterranean and global reference section for the Early and early Late Pliocene (LANGEREIS & HILGEN, 1991).

Cyclic bedding, interpreted as an expression of orbital forcing on sedimentation, is pervasive in the Trubi Formation of Zanclean age (HILGEN, 1987) and in the overlying M.Narbone Formation. The latter, as exposed on land, documents a progressive shallowing accompanied by increase in terrigenous input and sedimentation rate. Manganese-rich interbeds characterize the basal part of the M.Narbone Formation, and dark layers (?sapropels?) its upper part. Both types of sediments indicate periodic deposition at orbital frequencies.

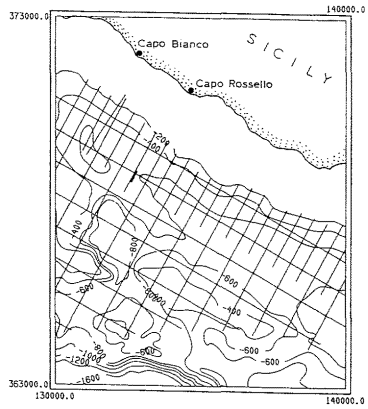
The proposed location is ideally suited also to investigate the PlioPleistocene boundary in an undisturbed equivalent of the Vrica section of Calabria.

Seismic profiles suggest that the sedimentary strata have not been affected by tectonism because the drilling target lies landward of the Strait of Sicily rift zone, in a fairly undeformed belt of the foreland basin (ARGNANI, 1990).

The rift system is considered to be of Pliocene age and, on its northern side, contains two small foredeep basins related to the Maghrebian fold-and-thrust belt (ARGNANI *et al.*, 1987). The Gela foredeep has a NW-SE trend (fig.1): its outer ramp where the proposed drillsite is located should allow the sedimentary record to be continuous: the parallel, low-amplitude, continuous reflectors seen on the seismics (fig.2) suggest that the ramp was out of the turbidite reach.

This drilling proposal is strongly supported by the Subcommission of Neogene Stratigraphy of IUGS.

Fig. 1 - Location of the study area with bathymetry and seismic grid. Line of fig. 2 indicated in bold.



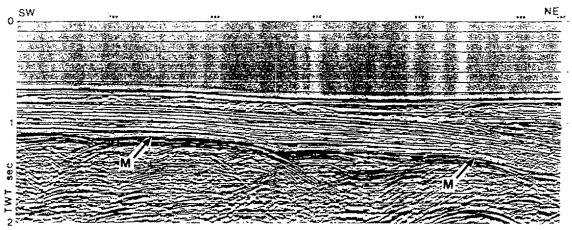


Fig.2 - Profile G82-122. Seismic facies of the outer ramp of the Gela Foredeep situated to the NE of the line. M is the top of Messinian evaporites.

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The Mud diapirs of the Mediterranean Ridge : A window to the deep composition of the Mediterranean Ridge accretionary complex

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Core analysis of the "mud breccia" recovered from four fields of mud diapirs and mud volcanoes identified on the crest of the Mediterranean Ridge (CITA *et al.*, 1981; 1989) allows to identify the source material from Cretaceous, Oligocene, and Early Miocene formations, with age progression from west (oldest) to east (youngest) (Figure 1).

The mud diapirs and volcanoes occur at the top of a steep escarpment on the inner side of the western and central Mediterranean Ridge. Although mud mobilization seems to be restricted to this narrow area of the ridge, high resolution seismic reflection data suggests that diapirs may be present also on the escarpment, and we interpret this prominent physiographic feature as the inner landward vergent deformation front of the Mediterranean Ridge.

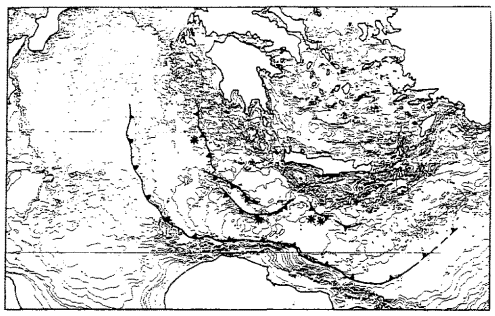
The deep origin of the diapiric material is documented by a) the Cretaceous, Oligocene and Miocene age, supported by characteristic planktonic foraminifera and calcareous nannofossils, b) the presence of methane with partial thermogenic origin (CAMERLENGHI *et al.*, in press), and c) the steep salinity gradient in the pore water (DE LANGE *et al.*, 1992) which indicates a provenance from pre-evaporitic strata. In addition, assuming that the diapiric material behaves like a fluid and that the domes are in hydrostatic balance with the host sedimentary sequence, a minimum source depth ranging from 600 m and 1000 m is required to produce the observed relief of the domes.

The smectite-rich clay mineral assemblage of the the three easternmost diapiric fields and the presence of quartz-arenites similar to the Numidian Flysh indicates that the source formations belong to the subducting African plate and that offscraping of preMessinian sediments occurs at least in the deepest portion of the ridge. Late Oligocene-Early Miocene gray clays of transitional depositional environment outcropping on the Northern African margin can be considered the analogue formation to those presently extruded as diapiric mélange on the Mediterranean Ridge.

An important implication of the deep origin of the diapiric material is that in some places of the ridge the décollement must be within Tertiaty sediments older that the Late Miocene, since mud diapirs are not thought to originate from below the décollement. If the present day décollement at the toe of the ridge occurs within the Messinian evaporites (KASTENS *et al.*, in press) then an upward migration of the décollement must have occurred during the evolution of the accretionary wedge since the Late Oligocene. Using the taper angle that can be measured at the Sirte deformation front on MCS line MS-33 (2.2°) a figure of 5-7 km depth is obtained for the upper Oligocene décollement below the ridge crest, where mud diapirism occurs.

Could mud diapirs be a drilling target? The presence of the Messinian evaporitic layer at shallow depth on the Mediterranean Ridge accretionary complex suggests a two-step (i.e. multileg) approach to investigate the structure of the ridge. The pre-Messinian sedimentary sequence on the Eastern Mediterranean is poorly known, and the structure of the ridge below the Messinian is even poorerly known. In addition, drilling through deformed salt layers is dangerous and in the case of the Mediterranean Ridge the dissipation of interstitial deep fluid pressure from sediments could be prevented by the evaporitic seal, so that anomalous overpressure could be expected. The mud diapirs and mud volcaneos found on the ridge crest have brought pre-Messinian sediments from the core of the ridge right to the surface, although in the form of mélange. If detailed stratigraphic work on a diapiric mélange will be impossible, detailed investigations of the geochemistry of the fluid and solid diapiric material obtained during shallow drilling (step 1) will provide useful informations on the deep composition of the ridge in preparation for a deep Mediterranean Ridge leg. (step 2).

Figure 1 - Location of mud diapirism (asteriscs) on the Mediterranean Ridge accretionary complex.



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The Alboran Sea : a case of extensional basin developed on a collisional orogen

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The Alboran Sea and the surrounding mountain chains form the westernmost segment of the Alpine Mediterranean orogenic belts. Like other Mediterranean basins, the Neogene Alboran Sea basin developed behind an arc-shaped mountain belt (the Betic and Rifean chains and the Gibraltar Arc) and is settled on the site of an orogen generated by collisional stacking from the Late Cretaceous. The region straddles the boundary between two major plates - Europe and Africa - which converged during the Neogene.

The Gibraltar Arc resulted from a continent-continent collision that involved different crustal domains. During the collision, the Alboran Crustal Domain, hanging wall of the collisional suture and itself composed of nappe metamorphic complexes, thrusted westwards over the Iberian and African thinned continental crust producing shortening and crustal thickening in the Gibraltar Arc (BALANYA and GARCIA-DUENAS, 1988). During the Miocene, the migration of the arcuate mountain front was nearly coeval with the extension in the inner part of the arc that resulted in crustal attenuation and basinal spreading in the Alboran Domain. The Alboran Basin thus formed since the early Miocene whereas outside the arc thrusting processes continued.

The fact that the present continental crust beneath the Alboran Sea is about 14 km thick indicates that considerable thinning of the previous thickened crust, formed by the collisional stacking, must have happened. The Miocene crustal thinning of the Alboran Domain is related to large-scale extensional detachment faults recognized in the emergent Alboran basement at the Betic chain (GARCIA-DUENAS *et al.*, 1992).

MCS profiles in the Alboran Sea show thick sedimentary sequences (in places up to 7 km thick) filling grabens or half-grabens between basement highs. Seismic studies and commercial well data reveal four major seismostratigraphic units, early Miocene to Recent in age, overlying the metamorphic basement (JURADO and COMAS, 1992). The Miocene sedimentary fill beneath the sea can be correlated with large outcrops of coeval marine sediments on land (Betics and Rif). This indicate that the "Miocene Alboran Basin" occupied an area that extended beyond the present limits of the present Alboran Sea.

The structure of the Alboran Basin (Fig. 1) results from superimposed tectonic stages in basin evolution. Earlier structures correspond to extensional grabens from several rifting episodes (from latest Aquitanian to early Tortonian). Magmatic events and mud diapirism occurred outing rifting. Later structures testify to a post-rift N-S contraction, involving folding and strike-slip faulting, which conditioned present day sea-floor morphology. The last faulting episode took place in the Early Pliocene and was related to basin subsidence or collapse during the Pliocene-Quaternary. This episode shaped the present coastal line. The direction of extension during the rift processes was not congruent with the coeval relative motion of Europe and Africa plates (COMAS *et al.*, 1992).

Conflicting hypothesis for the origin of the Alboran Basin have been proposed, considering such processes as extension induced by mantle diapirism or convective removal of a collisional lithosphere root. Other models consider this basin as an equivalent to Pacific-type subduction zones. Nevertheless, these different explanations are poorly constrained by data regarding the extensional mechanism and kinematics which caused crustal thinning of the orogen and originated the Alboran Basin.

The attributes summarized above allow to consider the Alboran Basin as a suitable location to investigate extensional processes in an overall convergent tectonic setting.

This is the reason why an international workshop during the C.I.E.S.M. XXXI Congress and Plenary Assembly (Athens, 1988) to develop ODP drilling initiatives in the Mediterranean identified the Alboran Sea as one of the potential area to address "investigations of deformation processes at convergent plate boundaries". After years of intensive survey on this subject, an international consortium of scientists submitted to JOIDES Office a proposal (reference n° 323-Rev, COMAS *et al.*, 1991) including geodynamic and tectonic objectives in the Alboran Sea. The drilling target in the Alboran Basin satisfies one of the priority objectives of the TECP: to investigate the dynamics of the extension collapse of collisional ridges resulting in the formation of arc-shaped orogenic belts. Also, this target complies with a prerequisite underlined by the TECP: the accessibility to the basement. Actually, in the case of the Alboran basin the compression and extension deformation of its basement is well known from onland geology as it crops out extensively throughout Betic and Rifean chains.

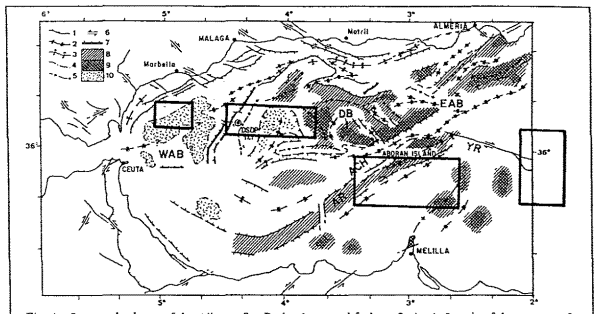

Fig. 1.- Structural scheme of the Alboran Sea Basin. 1: normal faults at 2s (twt); 2: axis of depocenters; 3: anticlines; 4: diapiric boundaries; 5: structural highs; 6: strik-slip components; 7: normal faults at 4s (twt); 8: acoustic basement presumed volcanic; 9: volcanic residual banks; 10: mud diapirs. ACH: Alboran Channel. AR: Alboran Ridge. DB: Djibouti Bank. EAB: Eastern Alboran Basin. WAB: Western Alboran Basin. YR: Yusuf Ridge. Squares: suitable drillsite-areas.

For tectonic purposes, deep drilling results in the Alboran Basin can provide accurate information on timing of extension-and-compression deformation and synchronous basin formation, rate and amount of subsidence, nature of the basin floor, role of volcanism, and interference between rifting and contractionneotectonic processes in the evolution of a young basin. Drilling here can clanfy the lithosphere defonnation mode, vital to the development of geodynamic models not only for this region but also for equivalent settings in nascent back-arc basins.

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Proposal for deep drillings in the Mediterranean Sea (Rhone Deep-Sea Fan and Var Ridge)

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The general aim of this drilling project is devoted to deep turbiditic sedimentation related to external forcing mechanisms such as sea-level changes, tectonics and climate.

We shall present here, among the main objectives of this project, those that concern the improvement of sequence stratigraphy model [1, 2] in deep-water settings; many of which are not universally recognized and usually are poorly documented.

The Rhone Fan in the Gulf of Lions [3] and the Var Fan on the Ligurian Margin [4][2], two of the main turbiditic systems of the northern Mediterranean margin, offer a unique opportunity to precise the relative influences of sea-level changes and regional tectonics on basinal sedimentation. These fans have in common several characteristics: their construction follows the same main eustatic event (Messinian salinity crisis), they were fed by common terrigeneous sources (the Alps) and they are both of Plio-Quaternary age. The main differences between them concern the nature of sedimentary input (probably much coarser in the Var system than in the Rhone Fan), and the physiographic and local tectonic conditions prevailing during their constructions. These differences resulted in contrasting modes of fan growth:

- The **Rhone Fan** can be considered as "typical" and relatively simple example of a turbiditic system. During its history, the prevailing physiographic characteristics of the Gulf of Lions margin were not different from those of today, and were very close to the general sequential model (broad shelf, well expressed shelf-break). Moreover, subsidence of the margin is known to have been relatively low and costant since earliest Pliocene, varying from about 26 m/100,000 years on the outer shelf to about 33 m/100,000 years in the basin 151

These analogies in the background conditions (physiography, subsidence) of the Gulf of Lions and of the sequential model, together with the relative simplicity of the sedimentary evolution of the Rhone Fan, make the Gulf of Lions and Rhone Fan good potential areas to test the general concepts of the sequential model of margin construction.

However, the sedimentary evolution of this fan shows some specificities that are not predictable by the model. Our observations indicate in particular (a) the existence of significant turbiditic sedimentation during relative rises of sea-level and sea-level highstands (*e.g.:* deposition of the sandy "neofan" during the Holocene highstand [6], and probable active channelized basin sedimentation during the lower Pliocene sea-level rise [3]), and (b) mass-movement prcesses at the end of lowstand channel/levee deposition, that is to say during the subsequent rises of sea-level [3].

It appears thus that the determination of the exact timing of deposition of this types of sediments is essential and will be considered as another objective for the proposed drilling.

- In contrast, the **Var System** must be regarded as a "atypical" turbiditic system. The main interest of this system lies in the specific physiographic conditions and the local tectonic activity that resulted in the overgrowth of a single levee (the "Var Ridge" southern levee). These conditions were, among others: absence of a shelf, which prevented accumulation during highstands, continuity between the Var River and the Var Canyon leading to the permanent feeding of the basin by the fluvial input, tectonic control of feeding axes leading to the stability of depocenters.

These specificities design the Var system as a good target for improving the general model.

Comparison between drilling results in the Rhone Fan, where sealevel changes are likely to be the main controlling factor of sedimentation, and in the Var System, where local tectonics played a greater role, is expected to highligh significant information on the relative influence of these two factors.

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[1]*Other institutions are likely to partecipate in the further elaboration of this proposal, still in preparation; it will be presented in the framework of an open discussion during which other objectives should be defined.*

[2]*The results concerning a comparative study of architecture and growth-pattern of both the Rhone Fan and Var Ridge will be presented during the section on "Deep sea depositional systems".*

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The contribution of scientific ocean drilling to the exploration of the Mediterranean

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The Ocean Drilling Program (ODP) is an international basic research program of scientific ocean drilling funded by 20 countries. Five of these countries border the Mediterranean: Spain, France, Italy, Greece and Turkey. Since the seagoing phase of ODP began in 1985, the drilling research vessel *JOIDES Resolution* has occupied some 250 sites, drilled about 600 holes and recovered about 70 km of core from all the major oceans of the world. ODP is the successor to the Deep Sea Drilling Project (DSDP) which ran from 1968 to 1983.

During the 25 years since the start of DSDP, only three DSDP/ODP legs have been dedicated to the Mediterranean Sea. As one would expect, the first leg, Leg 13 in 1970, was exploratory in its nature, comprising a dozen sites scattered throughout the region, from the Alboran Sea in the west to the Nile Cone in the east. Most of the holes drilled were quite shallow; at only two of the 12 sites did holes penetrate deeper than 500 m. Nevertheless, the recovery of Messinian evaporites gave birth to dramatic discoveries about the desiccation of the Mediterranean basins and to the hypothesis of the Gibraltar water fall. The fact that such major discoveries were possible with shallow drilling is essentially because these events occurred very recently in geological time.

Leg 42, in 1975, consisted of a similar number of sites to Leg 13. Again they were scattered throughout the region, including eight sites in the Mediterranean proper and three in the Black Sea. The holes drilled generally penetrated deeper than on Leg 13 and included a 1073 m hole in the Black Sea which bottomed in black shales.

By contrast, ODP Leg 107 was much more focussed, all the sites being located in the Tyrrhenian Sea. The primary thematic objective was to understand the evolution of a backarc basin in a continental setting. But since this was also the only leg to date in which hydraulic piston coring had been carried out in the Mediterranean, it was also possible to address several paleoceanographic objectives.

The present situation of scientific drilling in the Mediterranean is thus one in which a broad-brush regional coverage has been obtained, whilst thematically-focussed drilling has only been conducted in the Tyrrhenian Sea. APC/XCB coring, promising high recovery and undisturbed cores from the upper part of the sediment column, has not yet been attempted in most of the region. Furthermore, many of the holes drilled on Legs 13 and 42 were only spot cored.

The water depth in the Mediterranean is on average about a kilometer less than that in the major ocean basins. This could contribute to the operational efficiency of drilling deep holes. Deeper holes require the setting of re-entry cones, running casing, pipe trips to change drilling bits, in addition to wireline time to retrieve core barrels and make downhole measurements. The shallower the water, the less time all of these operations take.

Since Leg 42 there have been substantial improvements in the way scientific ocean drilling is conducted. Even since Leg 107 in 1986, there have been major improvements to downhole coring and logging equipment and to the equipping of the shipboard laboratories of the *JOIDES Resolution*. For example:

- The Adara device, located in the shoe of the APC, provides accurate in situ temperature measurements for heat flow determination.

- The Pressure Core Sampler (PCS) has been developed to bring cores with their contained gases back to the surface at ambient pressures. The PCS could be used, for example, to recover some of the very gassy sediments that were encountered on Leg 42B in the Black Sea.

- All good quality cores are routinely scanned with the MultiSensor Track (MST), measuring magnetic susceptibility, sonic velocity and density.

- The Formation MicroScanner (FMS) downhole logging tool is now regularly used to produce electrical resistivity images of the borehole wall.

- The shipboard computing system has been substantially upgraded to improve data transfer and assimilation. Further upgrades are in process.

The increasing range of physical property measurements made on cores in the shipboard laboratory is pushing ODP towards core-log integration. Comparison of shipboard measurements on cores with those obtained by downhole logging tools will eventually allow the two data sets to be fully integrated and core to be located at its proper place in the sediment column. By the time the drillship returns to the Mediterranean, possibly as soon as 1994, core-log integration should be far advanced.

At the roundtable workshop on "Focussing scientific objectives for deep drilling in the Mediterranean", a fuller presentation of ODP's technical and scientific capabilities will be made.

Tectonic Facies Concept Applied to Interprete the Geology of Cyprus

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Mountains formed by plate collision are exemplifed by the West Alps. Rock formations of the colliding plates are (1) overthrust, (2) underthrust, or (3) pushed out onto foreland. The three modes of deformation correspond respectively to those of (1) the Austro-alpine rigid basement nappes, (2) the Penninic melanges and mobilized basement nappes, and (3) the Helvetic cover nappes of the Swiss Alps. HSU and BRIEGEL (1991) proposed to consider the Austro-Alpine, Penninic, and Helvetic three major tectonic facies, and interprete the genesis of less well-known mountain belts of the world through comparison with the Alps.

The present Benioff zone under the Hellenic Arc dips to the north, and the Neogene tectonics of the eastern Mediterranean is commonly considered to have a southward vergence. Extrapolating from the Holocene to Miocene, the structural deformation of Cyprus has also been assumed to be a southward continuation of structures in Anatolia, characterized by a southward vergence; the Troodos ophiolites has thus been considered a fragment of ocean crust thrust up- and southward along one or more north-dipping thrust faults (e.g., BIJU-DUVAL and MONTADERT, 1978; ROBERTSON, 1990; 1991).

Two major tectonic units are present on the Island of Cyprus. The Kyrenia Range is underlain mainly by upper Mesozoic and Cenozoic formations, forming disharmonic folds and decollement thrusts. This style of deformation is typically that of a peeled-off passive-margin sequence. The southern half of the island is underlain mainly by the Troodos Ophiolite and by the Monia Melange.

That the Troodos represents ancient ocean crust is a concensus interpretation; the ophiolite complex is considered a huge slab in a tectonic melange. That the Monia Melange represents a tectonic melange now sandwiched in the suture zone between colliding plates is also a concensus interpretation. The question is the vergence of the deformation. Assuming that the Benioff Zone south of Cyprus dipped to the north during the Miocene as the Benioff Zone under the Hellenic Arc, the orthodox interpretation is to assume that a micro-continent, called by ROBERTSON (1990; 1991) the Monia Microcontinent has been underthrust beneath Cyprus. The orthodox model assumes thus that the Kerenia formations belonged to an overriding block.

The theoretical model for collision tectonics predicts, however, that a tectonic melange is the accretional wedge on an active margin, formed by shearing within a Benioff Zone which dips under the overriding block; the Saas-Zermatt and Arosa ophiolite melanges dip under the Austro-Alpine nappes. The Kerenia style of deformation is, however, not comparable to the rigid-basement thrusting of the AustroAlpine nappes; the style is more analogous to the tectonics of the Helvetic nappes. Considerations of comparative tectonics require that the Kerenia is a foreland deformed belt, formed by the plunger action of a *traineau écraseur* of an overriding plate.

HSU suggested in a memorandum to JOIDES drilling in 1989 that the Miocene Benioff Zone south of Cyprus may have dipped south, not to north. According to this model, the Troodos ophiolite underlies a back-arc basin which had its origin in Late Cretaceous back-arc seafloor-spreading. The Upper Cretaceous-Tertiary sedimentary sequence of the Kerenia Range is that of a passive-margin behind, i.e., north of the backarc basin. The frontal arc should then be located under the Eratosthenes Seamount! Such a paleogeographic interpretation suggests that the tectonics of the Cyprus deformation is typically that of a back-arc basin collapse. The ocean lithosphere under a back-arc basin, like that under the South China Sea today, dips under a frontal arc, causing the elimination of the basin and an arc-continent collision. The suture zone of such a collision is located on the back side of the arc, exemplifed by the Lichi Suture of the Mio-Pliocene arc-continent collision in Taiwan. The Monia Melange was the accretional wedge under the Eratosthenes Arc. The melange, including the Troodos slab of ocean lithosphere, was then sandwiched in the suture. The plunger action of the overriding arc and the melange caused the decollement deformation of the Kerenia-Range sequence.

This interpretation of the Cyprus tectonics presents an alternative to the current orthodoxy. Ocean- drilling south of Cyprus should yield data to discriminate the two working hypothesis. If the vergence of the Miocene deformation was directed southward, drilling south of Cyprus should penetrate a foreland deformed belt, similar to that of the Helvetic Alps, or that of the Appalachian Valley and Ridge. If, however, the vergence of the deformation caused by the Miocene collision was directed northward, ocean drilling should penetrated an island arc sequence (volcanic or non-volcanic) under the upper Neoene sediments of the Eratosthenes Seamount.

The settlement of the question of the Cyprus tectonics might help resolve the controversy on the tectonics of the Antalya Melange. RICOU and others (1979), the "super-nappists" suggested a southward thrust of the ophiolites from northern Turkey during the suturing of Anatolia. ROBERTSON (1990; 1991), on the other hand, considered the Antalya Ophiolite the lithosphere under a small ocean basin, the Isparta Angle; the ophiolite, according to this model, was emplaced "outward" from the Isparta Angle and onto the adjacent, relatively autochthonous carbonate platforms." My interpretation of the Cyprus geology supports the postulate by ROBERTSON. In the scheme of a back-arc basin complex, the continental crust under the Kerenia Range (and under the Troodos Ophiolite) could be interpreted as the foundation of a remnant arc, similar to the KyushuPalau Ridge of West Philippine Sea. The Kerenia passive-margin sequence was laid down on the south side of this remnant arc. That Antalya and Troodox ophiolites were, according to this model, the ocean lithosphere under the two back-arc basins north and south of the remnant arc respectively; those basins were eliminated by the mechanism of back-arc basin collapse, and the ophiolite nappes were thrust northward onto carbonate platforms.

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X

The Eratosthenes Seamount : a fossil superstructure in the Eastern Mediterranean

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In the present study we interpret the structure of the Eratosthenes Seamount and nearby areas of the southeastern Mediterranean. We integrate available seismic reflection profiles with other geophysical data and with plate kinematic considerations. This allows to distinguish between structural elements of different ages and to relate them to the evolution of the Levant basin, especially in Mesozoic times.

It is found that the Eratosthenes Seamount, one of the most prominent features in the southeastern Mediterranean, forms the highest part of a much larger structural high. The latter is interpreted as a partly volcanic construction over a continental block which was stranded in the Levant basin following Early Mesozoic rifting. This structural high is defined by a prominent seismic reflector which rises several km towards the Eratosthenes Seamount. Mapping of this reflector defines a high (Eratosthenes Structural High, hereafter ESH) which approximately ovelaps the extent of a large magnetic anomaly. We find that the magnetization of the rocks causing this anomaly, deduced in a previous study, is similar to that expected of Early Mesozoic rocks on the African plate. Since at the time rifting-related volcanism was indeed widespread in the Eastern Mediterranean border of Africa, we infer that the ESH formed at that time, coevally with the rifting that formed the Levant basin. However, there was not much motion between this block and Africa since then.

Superimposed on the ESH is a quadrilateral graben delimited by steep fault scarps. As this graben encloses the Eratosthenes Seamount and its slopes, downfaulting of its central area produces a moat which surrounds the topographic high. Messinian evaporites pinch out and onlap the flanks of the ESH outside the graben and seem to be absent in the graben. This shows that the ESH was a well expressed physiographic feature in Messinian times, its peak (the present seamount) having been more than 1500 m higher than the top of evaporites. The steep foults delimiting the graben are interpreted as Miocene strike-slip foults, reactivated with a vertical motion in post-Messinian time. Strike-slip motions presently occur mostly on local structures around the Eratosthenes Seamount whereas the ESH, thicker and more buoyant than the surrounding eastern Mediterranean crust, interrupts the process of subduction along the central segment of the Cypriot Arc, thus causing the younger uplifting phases in Cyprus.

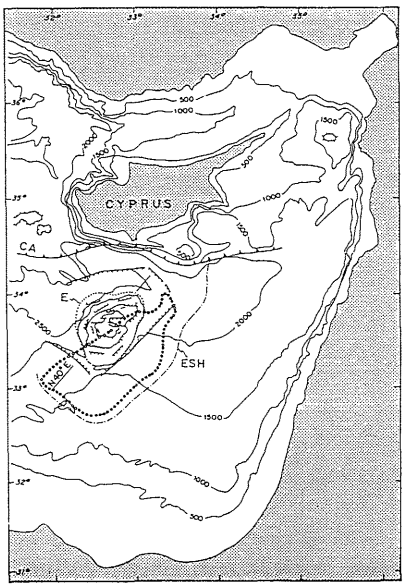

Fig. 1 - The Eratosthenes Seamount, E (dots) forms the central and highest part of the larger Eratosthenes Structural High, ESH (dots and dashes). Note the good correlation between ESH and the zero-contour of the magnetic anomaly (open circles). Steep faults delimit the moat around the seamount, forming a quadrilater graben whose axis strikes about N 40° E. The shape of Africa-Anatolia plate boundary, the Cypriot Arc (CA), is affected by the collision with the ESH which interrupts the process of subduction along this segment. Bathymetry simplified after Hall (1980, 1981). Contour interval is 500 m.

Eratosthenes Seamount : Mid-Ocean recorder of paleotectonics and paleo-oceanography of the Eastern Mediterranean Region

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Eratosthenes Seamount is the most prominent physiographic feature on the eastern Mediterranean seafloor. Located south of Cyprus, it is at the heart of the tectonic collision zone between Africa and Eurasia. Dredged samples recently recovered from the seamount suggest that it has been a high structural feature since the Cretaceous, in effect a dip-stick or recorder of tectonic and oceanographic changes especially those tied to eastern gateway closure, destruction of the Tethyan seaway, and evolution of the Cyprean arc.

Eratosthenes Seamount rises over 2 km above the regional seafloor; its summit is at a water depht of 690 m. The feature appears to be a folded structure of sedimentary and perhaps metamorphic rocks. Relief is not steep, and the slopes and summit are mantled with a thick accumulation of sediments. Today it is isolated from the surrounding Nile Cone, Levant Basin and Cyprus by a deep moat-like depression that widens to the west forming the Eratosthenes abyssal plain, thus this sedimentary mantle appears not to be formed so much of Quaternary debris but rather of geologically-older sediments. Seismic reflection profiles suggest the seamount has no evaporite deposits left by the Messinian dessication event, thus was isolated as a high structure at least back to the Miocene. Heat-flow measurements, gravity and magnetic anamoly patterns, and limited sampling programs suggest no volcanism associated with the seamount.

Recent dredging recovered chalk of middle Cretaceous age, covered with a dark-colored calcareous crust containing numerous shell molds of Miocene age. These geological ages remain tentative. Never the less, a Cretaceous age implies that Eratosthenes seamount could bear evidence of sedimentary and structural events that affected the eastern Mediterranean region since that time, such as the Senonian folding of the Syrian arc anticlines that affected much of the Levant. Miocene age crusts may imply uplift and that the seamount stood high above regional sea-levels, additional criteria that it offers a window through the Messinian evaporite into older sedimentary sequences.

We suggest that Eratosthenes seamount is likely a promontory of the African plate, protruding northwards and in collision with Cyprus, the latter a southward-protruding promontory from Anatolia. This collision preceded the Africa-Eurasia closure that resulted in the Hellenic arc. The transition of the collision zone westwards drastically reduced the rate of closure in the Cyprean arc. Since the seamount was unaffected by other eastern Mediterranean tectonic events, including halokinetic processes associated with Messinian evaporite deposits, the Cyprus-Eratosthenes collision zone may preserve the earlier closure events. Here collision events apparently were aborted, preserving for study by drilling the record of early stages of continent-continent collision.

Here then is a setting where a drilling program would illuminate the major geological and oceanographic history of the eastern Mediterranean region:

- plate tectonic history in connection with the early stages of continentcontinent convergence and collision,
- paleo-oceanographic consequences of this tectonic activity, including the destruction of the eastern oceanic gateway and the uplift of the Levant, all influencial on regional and global changes in oceanographic circulation,
- sedimentary history and paleo-oceanography preceeding, during and following the Messinian dessication event, one of the very few areas in the eastern Mediterranean Sea where such a window exists for safe drilling into and through these deposits or their time-equivalent deposits,
- late Pleistocene and Quaternary sedimentary history and paleo-oceanography connected with major glacial and interglacial periods, such as sapropel formation, sea-level variation, climatic modifications, major fluvial modifications, etc.

X

Deep Sea Drilling for Earliest Pliocene Sediments in the Eastern Mediterranean

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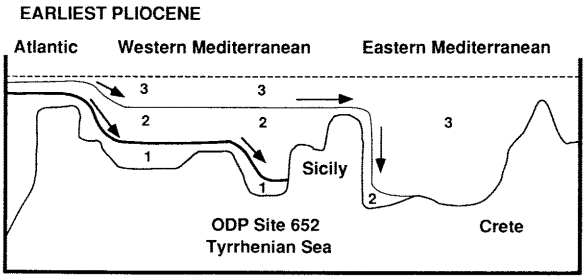
During the Messinian (latest Miocene) Salinity Crisis, the normal water exchange pattern between the Atlantic and Mediterranean was disrupted due to the relative lowering of the sea level in the latter with respect to the former. Marine waters flowed into the desiccating basins with no return flow to the open ocean (CITA and RYAN, 1973). The Zanclean (earliest Pliocene) termination of evaporite conditions in the Mediterranean was apparently facilitated by a major eustatic rise in sea level that allowed increasingly greater amounts of marine water to flow into the Mediterranean and overcome the extreme negative hydrologic balance that had produced the Salinity Crisis (MCKENZIE *et al.*, 1988). This terminal flood is manifested in the sedimentary record by marine pelagic sediments directly overlying the continental evaporitic sediments and marks the stratigraphic boundary between the Miocene and Pliocene.

Deep sea drilling in the Mediterranean during DSDP Legs 13 and 42 demonstrated that the earliest Pliocene sediments overlying the continental deposits were not always time synchronous, i.e. the flooding and infilling of the multiple basins were undoubtedly progressive dynamic processes (RYAN, HSU *et al.*, 1973; HSU, MONTADERT *et al.*, 1978). During ODP Leg 107, deep sea drilling at Site 652 in the Tyrrhenian Sea recovered a sedimentary sequence comprising an apparently complete Miocene/Pliocene boundary section (SHIPBOARD SCIENTIFIC PARTY, 1987). The sediments appeared to have been continuously and subaqueously deposited during the transition from continental to marine conditions. A high-resolution bio-, magneto-, and chemostratigraphic study of this sequence delineated a series of paleoceanographic events within the 300,000 yrs. period following the initiation of the earliest Pliocene terminal flood (MCKENZIE *et al.*, 1990). These events can be correlated to changes in amount and depth of water exchange between the Atlantic and Western Mediterranean with the infilling of the western basin occurring progressively during the first 250,000 yrs. post flood. Moreover, preliminary studies of the relative strontium isotope ratios (87Sr/86Sr) of the lowermost Pliocene sediments from three locations in the Mediterranean (ODP Site 652-Tyrrhenian Sea, Sicily, and Crete) indicate that the marine flooding and infilling of the Tyrrhenian Basin may have occurred earlier with continental conditions in the Sicilian and Cretian Basins being maintained progressively longer with increasing distance from the Atlantic source (MCKENZIE *et al.*, 1989). The figure below illustrates the progressive infilling of the Mediterranean from west to east.

Our understanding of the timing and consequences of these paleoceanographic events recorded in basinal sequences deposited across the Miocene/Pliocene boundary has been limited by the quality of material available for study. Using the advanced drilling technology of the JOIDES Resolution, it would be possible to have excellent recovery of sediments from a number of sites in the deep Mediterranean basins. In particular, selection of an appropriate site (or sites) in the Eastern Mediterranean to compliment Site 652 would provide a record of environmental changes that could be correlated with the paleoceanographic events delineated for the Western Mediterranean. Specific factors to be evaluated could include: (1) the relative timing of the cessation of continental conditions in the Eastern Mediterranean, (2) the influence of paleoclimate on the hydrologic balance between meteoric input and marine inflow across the shallow sills to the west and, hence~ on the evolution of the earliest Pliocene water body and (3) the development of two-way exchange of marine waters between the western and eastern basins and its significance for the Mediterranean paleoceanography and global climate.



Based on preliminary strontium isotope ratios, the earliest Pliocene marine infilling of the Mediterranean from the Atlantic occurred in three stages: Stage 1 - as eustatic sea level rose, the deeper basins of the Western Mediterranean, such as the Tyrrhenian, were gradually infilled by waters cascading down the western sill, Stage 2 - the waters gradually filled the deeper basins and transgressed across shallower morphology, such as the Sicilian Basin, and finally cascaded into the Eastern Mediterranean, and Stage 3 - with continued rising eustatic sea level, a threshold level was passed allowing waters to completely infill the basins of the Eastern Mediterranean. Diagram by A. Isern after CITA and RYAN (1973).

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The OGS multichannel seismic coverage of the Mediterranean Sea (MS-lines)

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From 1969 to 1982 the Osservatorio Geofisico Sperimentale (OGS), with seat in Trieste, collected 39,500 km of multichannel sesmic reflection lines in the Mediterranean Sea (Figure 1). These lines can be regarded as the only comprehensive seismic datatset of the Mediterranean and the Black seas collected by a public research institution.

Unfortunately, only part of the dataset is known to the Italian and European scientists: some lines have been published (FINETTI, 1976; FINETTI and MORELLI, 1972; 1973; FINETTI, 1982), others have been made available to scientists for detailed studies. Nevertheless, a systematic analysis of all the lines according to the latest re-processing techniques has never been done. Recently, a test performed on a few lines from the central Tyrrhenian Sea has shown that the application of widely used re-processing steps like deconvolution in the FX domain allows to outline details that could not be resolved with the 20 year old processing technique, thus improving greatly the data quality.

Since about half of the Mediterranean and Black seas data set is recorded on 21traces tapes (an obsolete format) OGS has started a program, partly supported by public funding, of systematic copying and re-formatting in standard SEG Y format of all the lines, so that they can be re-examined and re-interpreted in the frame of new national and international cooperation.

The geological themes covered by the lines are numerous, as complex and variegated is the geological structure of the Mediterranean Sea:

Black Sea lines: The Black Sea has gained recent growing attention for geological and oceanographic research. The structural relationship of the basin with the AlpineHimalayan orogen is important in terms of paleoceanographic reconstruction of the Paleo-Thethys ocean. The development of shale diapirism in the fine grained sediments of the Danube Cone is an additional theme of growing interest.

Levantine and Ionian seas lines: The Eastern Mediterranean is a unique geological laboratory where lithospheric, tectonic, paleoceanographic, and geochemical themes can be addressed, as demonstrated by the numerous drilling proposals submitted to the Ocean Drilling Program, mostly based on existing published and unpublished MS lines, and MAST-II proposals submitted to the EEC: nature of the Ionian and Levantine lithosphere, incipient continent-continent collision as the last stage of the AlpineHimalayan orgenesis, evolution of a salt-bearing accretionary complex, origin of sedimentary melanges of diapiric origin, relation between convergent plate margins and back-arc extension, mechanichs of emplacement of ophiolites; climatically induced stagnation of a marginal sea, paleoclimatic reconstruction in the post-Messinian; brine migration below the seafloor, deep fluid circulation in accretionary prims are the highlights.

Tyrrhenian Sea: The evolution of the Tyrrhenian back-arc basin has been addressed by ODP Leg 107 based on drill sites located on the existing versions of MS lines. The lithospheric theme of mechanism of emplacement and composition of upper mantle peridotites in an back-arc extensional setting has been introduced by this leg to the attention of the scientific community.

Sardinia Channel: The geological structure of this area has been recently interpreted as the off-shore extension of the Apenninic orogenic belt, in continuuity with the northern Africanan Meghrebian fold belt. Its evolution is thus critical in the study of a collisional processes where not only the sedimentary cover, but also the crysatalline basement can be easily reached by seismic investigation. An ODP drilling proposal based on the present version of MS lines has been filed to ODP.

West Sardinian Margin: This continental margin offers the possibility to investigate the crustal structure developed during the opening of the Balearic Sea. MS lines are presently employed within ECORS-CROP programs.

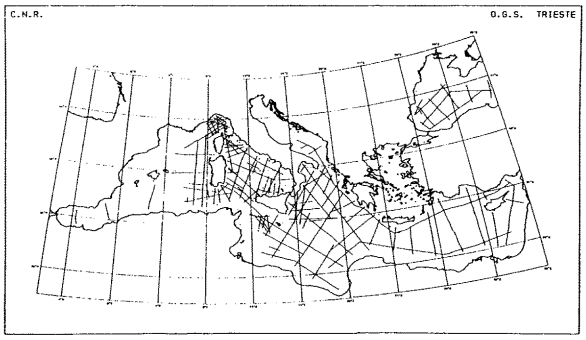

Figure 1. Location of Mediterranean Sea (MS) and Black Sea (BS) MCS lines collecte by OGS from 1969 to 1982.

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X

Drilling the Eratosthenes Seamount: Mediterranean collision tectonics and Plio-Quaternary palaeo-oceanography in the light of the geology of Cyprus

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Continental collision is one of the tectonics themes of COSOD 2. Drilling the Eratosthenes seamount and adjacent base-of-slope to the north affords an excellent opportunity to investigate initial continental collision processes. Also, the Plio-Quaternary sediment cover is capable of documenting Palaeoceanographic events, including sapropel formation.

The enormous Eratosthenes seamount (relief over 2000m), sited south of the Cyprus base-of-slope is widely believed to be a continental fragment located near the northern margin of the African plate. The crust to the S and W is believed either to be oceanic with a thick sediment cover, or thin continental crust, related to Mesozoic rifting of Neotethys in the Eastern Mediterranean. Recent data suggest more oceanic conditions to the west and more continental to the east. The foot of the slope south of Cyprus is believed by many to be an active northward dipping subduction zone. A trench is well expressed off SW Cyprus. Subduction is less well constrained to the east of Cyprus and this area may be undergoing collisional and/or strike slip deformation.

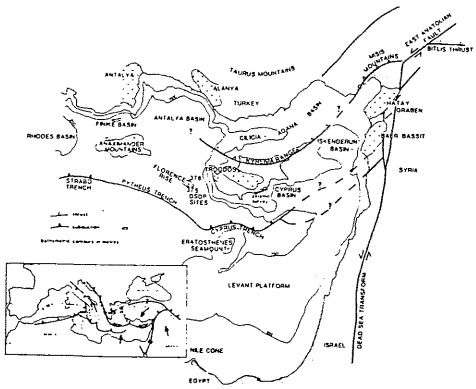
Available seismic, dredge and scarce piston coring data (from more than 8 international cruises over 20 years) suggest that the Eratosthenes seamount is a preMessinian structure, overlain by a thin, but complete Plio-Quaternary succession. The seamount is surrounded by a deep sediment filled moat, possibly caused by tectonic downwarping. The north margin is rugged and fault controlled, while the south margin is smoother. Dredging has retrieved samples of granite, Jurassic and Cretaceous limestones, serpentinite, arkosic sandstone and Mn-deposits, but the stratigraphy of these units is unknown.

An added advantage of drilling the Eratosthenes seamount is that the Neogene-Quaternary sedimentation and tectonics of Cyprus to the north is now extensively documented. During the Miocene, southern Cyprus was compressed and uplifted along several broadly E-W trending lineaments. These lineaments were colonised by patch reefs in the Late Miocene, while intervening basins were infilled with mainly bioclastic gravity flows and pelagic carbonates. The Messinian evaporates precipitated in small, semienclosed basins created by local tectonic processes. During the early-Mid Pliocene, southern Cyprus was relatively tectonically quiescent, undergoing shallow marine clastic sedimentation derived from the, by then partly uplifted Troodos ophiolites to the N. By contrast, areas to the north of the Troodos ophiolite (Mesaoria plain) were dominated by extension processes during Late Miocence/mid Pliocene time. During Late Pliocence-Quaternary the whole of central Cyprus was strongly uplifted. Sedimentation was controlled by the combined eifects of accelerating, then waning tectonic uplift, punctuated by glacio-eustatic sea-level change. Alluvial fans and fan deltas shed coarse ophiolitederived sediments into the Mediterranean Sea around Cyprus. A flight of marine terraces (containing dated corals) were cut during sea-level highstands and back-filled with littoral/shallow marine carbonate during regressions. During the Late Quaternary/Holocene, tectonic uplift of southern Cyprus slowed: archaeological evidence points to submergence of some coastal areas. Drill results from the Eratosthenes seamount can thus be evaluated in the light of a substantial on-land data base.

To solve tectonic and palaeo-oceanographic problems two drill holes are proposed, which can be selected for drilling based on existing data (further site surveys however may be necessary).

Hole 1: on the crest of the seamount where the Plio-Quaternary sediment cover is most intact and the basement can be sampled. This site will document the Plio-Quaternary succession including sapropels, determine subsidence history and the nature of basement (including its possible tectonic rotation).

Hole 2: beneath the N slopes of the seamount down to basement. This will test the hypothesis of tectonic downbuckling of the seamount and possible break-up due to northward subduction. An alternative hypothesis that a southward (rather than northward-dipping) subduction zone underlies S. Cyprus (K. HSU) might also be tested. Finally it is assumed that these shallow drilling objectives will be piggy-backed onto a drill leg including the Mediterranean Ridge area. Deeper objectives must await further data collection in the Eastern Mediterranean.



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Deformed units of continental basement in a collisional setting: the Sardinian-African Strait in Central Mediterranean

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Geological evolution and tectonic setting

The main geological features of the Sardinian-African Strait are shown in figure 1 (TRICART *et al.*, 1991). A 350 km wide submarine collisional chain, involving several tectono/stratigraphic units of the European and African plates, extends from Sardinia island to the Pelagian sea foreland.

Tectonically this collisional belt is composed (from top to bottom) of continental crystalline nappes and cover thrustsheets, mainly emplaced with S and SE vergences in latest Oligocene to Pliocene times (CATALANO *et al.*, 1989; COMPAGNONI *et al.*, 1989; BEN AVRAHAM *et al.*, 1991).

The main regional tectonic features are two low-angle SE-verging overthrusts. The outermost one, Burdigalian-Langhian (?) in age, represents the overthrust of the Kabylo-Calabrian crystalline nappes (CPK zone of Fig. 1) over the carbonate and clastic foredeep sequences of the African margin. The inner overthrust, perhaps Early Miocene in age, marks the tectonic contact between the Kabylo-Calabrian units and the superimposed Sardinian ones. The overall tectonic style, driven by the drifting and counterclockwise rotation of the Corsica-Sardinia microplate, records a large-scale intracontinental collision with development of a wide crustal shear zone, accompanied by a low-grade metamorphic re-equilibration in the Kabylo-Calabrian Hercynian assemblages. After this event tensional and strike-slip tectonics developed in the region during most of the Neogene.

Since late Pliocene the area is involved in compressional and transpressional deformations producing basin inversion and small-scale thrust faults along the contact between the Corsica-Sardinia block and the Kabylo-Calabrian units (TRICART *et al.*, 1990, 1991; TORELLI *et al.*, 1992).

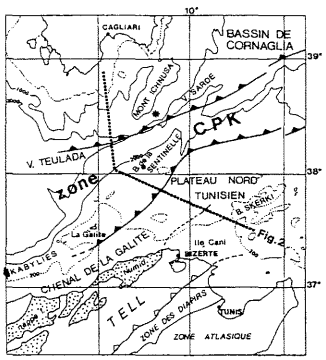

Fig. 1

The proposed drilling and its main goals

We propose to drill one deep Hole (> 1 km bsf) in the Sardinian-African Strait (Fig. 2), in order to penetrate through the thrust surface separating the upper crystalline units of Sardinian type from the lower units of Kabylo-Calabrian type. Although this feature developed mostly in Early Neogene times, there are indications that tectonic activity, both with compressional and strike-slip character, is still active in the Sardinian-African Strait.

The purpose of the Hole would be to determinate the rheological nature (brittle vs. ductile), the fluid characters and the physico-chemical rock parameters associated with the thrust surface, which is clearly shown on figure 2 as a strong reflector inside acoustic basement intervals.

This data set should elucidate the mechanics of thrusting of continental basement units, at least at shallow crustal levels, and the interpretation of similar reflectors detected on deep seismic profiles shot in continental crust.

Additional goals of the proposed Site would be a better resolution of regional geology of the Central Mediterranean and of the stratigraphic and structural data obtained during Leg 107 for the nearby Tyrrhenian basin.

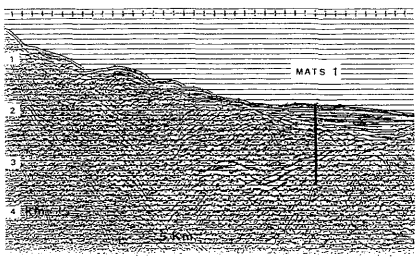

Fig. 2

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X

The igneous floor of the Marsili Deep Plain : how did the "Oceanization" propagate in time and with which products ?

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The numerous example of back-arc, arc volcanic systems which are located in different structural settings are frontally bordered either by oceanic crust or by orogenes; this second case being particulary widespread in and around the Mediterranean Sea. The new igneous crust of the interarc-arc complexes of the Tyrrhenian shows a wide composition spectrum due to the highly different nature of magma sources, as are, on one side, the MORB producing mantle diapir of the Vavilov basin (ODP Site 373 and 655) and, on the other side, the supra-subduction wedge of the Marsili basin (Site 650) and the northern part of Vavilov basin (Site 651).

In the Southernest Tyrrhenian Sea a sequence of volcanic islands and seamounts form the concave arc of the Eolie. The Marsili deep basin borders the internal side of this arc. The basin central area is occupied by a big volcano, (from 3400 to 485 m bsl). The rilief divides the basin area roughly in two parts, western and eastern with maximum depths of respectively 3500 and 3400 m.

Figure 1 shows that the magnetic field related to the deep basin, according to the aeromagnetic survey commissioned by AGIP, is made up by a series of positive and negative anomalies which do not have the linear, correlatable patterns of the mid-oceanic ridges. The physiographic high of the seamount is associated with an elongated positive magnetic anomaly of high intensity which likely belongs to the Brunhes because of the state of freshness of the magmatic products distributed over a wide depth range and the young K/Ar age (not greater than 0.2 Ma) of some eruptions from the summit. The negative magnetic anomalies which flank the positive axial zone can be roughly correlated with the two small side-reliefs situated to the northeast (from 3400 to 2550 m waterdepth) and to the southwest (from 3350 to 3000 m) of the seamount, respectively.

In the west margin of the bathyal plain at a distance of 40-45 Km from the Marsili physiographic axis, an overall round-shaped high of the magnetic field with maximum intensity of about 170 nT is present. To the east-southeast, at an approximate distance of 35 Km from the seamount axis another round-shaped positive anomaly occurs which has an intensity up to about 60 nT. ODP Site, 650, located in the western margin of the Marsili basin, bordering the positive widespread anomaly (170 nT) mentioned above, succeeded in its aim of ascertaining nature and age of the deep-seated igneous floor: volcanic manifestations having (altered) basaltic andesite composition took place around 1.9-1.7 Ma ago.

Chronological data now available clearly indicate a diachronous activity, that is the interarc volcanism of the Vavilov and Marsili abyssal plains developed after the magmatic activity ceased in the adjacent remnant arc to the west and before it started in the new one to the east. Also in the Mariana arc-backarc sequences, during the early stages of interarc basin opening, arc-related volcanism is absent both on the remnant arc and the migrating forearc plate. Despite the significant differences concerning the crustal basement and the rispective geological frameworks, the Tyrrhenian basin and the above-mentioned region share fundan1elltal analogies, in terms of timing of tectono-magnetic events.

Specific questions to address in the Marsili region include: - Where did the early stages of the oceanization occur?

- Which were the composition, serial affinity, distribution and evolution of the rocks as the back-arc basin widened and foundered?
- Which were they as the basin ridge grew in height?
- To what extent was the composition of late-stage magmas which erupted at greater depth of the axial zone arc-like? Was the arc signature less pronounced than at shallower depth?

In the Marsili basin a first objective of drilling would be in the site of a positive roundsh.lped magnetic anomaly located in the eastern margin of the plain. It is expected that this site should provide valuable information on the age, petrochemical character and distribution of the early stage of the igneous crust formation, and hence on the decoupling mechanism of the subducted segment of the Adria-African plate apart from the overriding Tyrrhenian lithosphere.

A second objective of drilling would be in the site of negative magnetic anomaly located in intermediate position between the positive anomalies of the Olduvai and Brunhes. As mentioned above, the products associated to the positive magnetic anomalies of Brunhes and Olduvai occur, respectively, in the axial zone and the western margin of the Marsili basin. This site could be located in the area of the lateral relief to the WNW of Marsili volcano. It is expected that the site should ascertain whether the magmatic products related to this anomaly are intermediate in age (late Matuyama) or not, with respect to the adjacent igneous bodies.

A third objective of drilling would be in the site of the intense positive magnetic anomaly. Its location could be at the southern axial edge of Marsili volcano where deepseated basement of the late stage is expected to be present. One of the major objectives of this site is to study the nature of the volcanites with respect to the greater depth of the axial zone. Products from greater axial depth should have composition with less pronounced volcanic arc sigllature and maybe MORB-like characteristics.

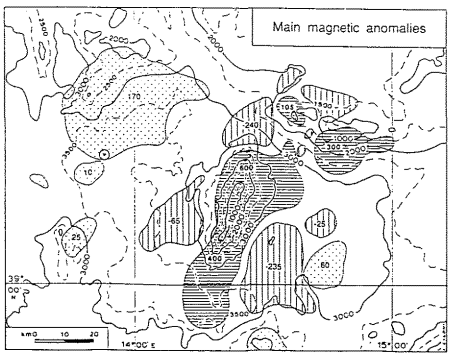

Fig. 1 - Main magnetic anomalies and bathymetry of the bathyal plain of Marsili (SE Tyrrhenian Sea). Bathymetry intervals of 1000 and 500 m (dashed lines). Marsili smt. is located about 45 nm to the NW of the islands of Salina and Lipari (Aeolian arc).
Stippled = positive anomalies of the Olduvai event, or presumed to belong to the Olduvai; circle and triangle = ODP Site 650; north-south stripes = negative anomalies presumed to belong to the late Matuyama (post-Olduvai); east-west stripes = positive anomalies of the Brunhes.

X

The evolution of the Atlantic-Mediterranean Gateways during the Neogene and Quaternary

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The Mediterranean is a semi-confined basin with a mean depth of around 1500 m separated from the Atlantic by a narrow sill, the Straits of Gibraltar, which is only 10 km wide and 300 m deep. Its reduced dimensions impose a low heat exchange by marine advection with the open Ocean and, therefore, local climatic conditions (strong evaporation in relation to precipitation) become very important.

The main factors governing the Atlantic-Mediterranean water exchange are: a) Atlantic water properties, b) local Mediterranean climate (the evaporation-precipitation balance E-P) and c) the geometry of the thresholds (BETHOUX, 1984). However, these parameters did not remain constant through time and therefore the Atlantic Mediterranean water exchange was very variable throughout the Neogene and Quaternary with the subsequent influence over the Mediterranean and global ocean history. After the closure of the Mediterranean-Indian Ocean connection, the only communication of the Mediterranean with the Global Ocean was through the Betic-Rifian corridors throughout the Miocene, and the Alboran-Gibraltar strait during the Pliocene and Quaternary. These regions did have a very important interest for paleoceanographic studies.

The climatic and oceanographic evolution throughout the Miocene was characterized by repetitive episodes of expansion and retreat of the antarctic ice sheets, causing global sea level changes. For a particular interval of time and a specific geometry of the North Betic Corridor, the global sea level rises and falls will determine different sections of the upper and lower Atlantic-Mediterranean flows and therefore different patterns of water exchange between them. The depth and width of the sills is also related to the tectonic and sedimentary evolution of the gateway (uplift, subsidence, olistostrome sliding, overthrusting, sedimentary filling, etc.). On the other hand, the global climate evolution and particularly the local climatic response, led the Mediterranean to modify the patterns of exchange with the open Ocean.

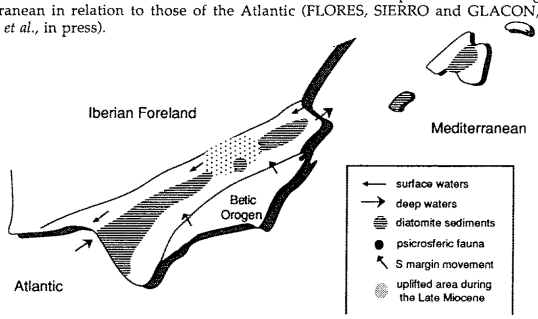
From the Paleoceanographic point of view, the Mediterranean evolved during the Miocene from being a region of the Open Ocean to becoming a marginal sea with important implications for its hydrography and its biotic communities.

During the Lower Miocene, both foredeeps were large and deep enough to allow the deep Atlantic waters to enter into the Mediterranean. Psychrospheric microfaunas of that age were found by BENSON (1976) in different places of the Betic Foredeep. During the Middle and Late Miocene the foredeeps became pregressively narrower and shallower and the deep communication restricted, leading the Mediterranean to become a marginal sea. Specially at the Langhian-Serravallian boundary an important reduction in the section of the Betic corridor occurred, causing the restriction of deep communication and conditioning the evolution of the deep Mediterranean ecosystems from that time to the present day related to an increase in the residence time of Mediterranean waters (VERGNAUD GRAZZINI, 1983).

During the Middle to Upper Miocene, diatomite sediments accumulated mainly in the southern margin of the Betic passage from the Atlantic coast to the Balearic Islands. The micropaleontologic and sedimentary features of these siliceous sediments, along with their preferred location in the southern part of the basin, strongly suggest that they were related to the coastal upwelling of deep Atlantic waters during a period of estuarine circulation between the Atlantic and the Mediterranean (SIERRO *et al.*, 1989, 1990). Deep microfaunas and diatomite sediments are found at least to the Middle Tortonian (approx. 8 to 7 Ma), supporting the hypothesis of a deep communication until that time through this gateway.

During the high sea level periods of the Upper Tortonian the hemipelagic sediments of the Guadalquivir basin were affected by bottom currents. These sediments were compared to recent sediments of the Gulf of Cadiz winnowed by the Mediterranean outflowing Waters (MOW) (SIERRO & FLORES, 1989; FLORES, SIERRO & BARAZA, 1991).

Immediately prior to the Tortonian Messinian boundary a large volume of olistostromes coming from the South partially filled the basin, causing a fast change in the geometry of the basin The coincidence of this event during a period of low *sea level* probably determined a restriction or closure of the Northbetic strait near the Tortonian-Messinian boundary. At the same time some anomalies were described in the calcareous plankton assemblages of the Mediterranean in relation to those of the Atlantic (FLORES, SIERRO and GLACON, in press; SIERRO *et al.*, in press).



On the other hand, BENSON *et al.* (1991) recognized an Atlantic Mediterranean water reversal near the Tortonian-Messinian boundary based on the occurrence of psychrospheric faunas in the South Rifian Gateway. During the Messinian the South Rifian Basin evolved almost parallely to the Guadalquivir Basin, but probably, the last episodes of water exchange immediately before the Salinity Crisis occurred through the South Rifian Corridor.

After the Messinian salinity crisis the Atlantic-Mediterranean water exchange probably took place through the Gibraltar-Alboran Corridor. The tectonic and sedimentary evolution of this area have conditioned the exchange dynamics since the Pliocene. The sea level rise approximately isochronous with the Micene-Pliocene boundary which reestablishes the communication is recorded in the Guadalquivir Basin by a condensed section related to a downlap surface.

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Chemical parameters distribution in the Ionian Sea during POEM-06 Cruise (October 1991)

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In this paper the dissolved oxygen and nutrients distribution of the POEM grid for the Ionian Basin is reported (Fig. 1), data were collected in October 1991 during the Italian POEM 06 Cruise.

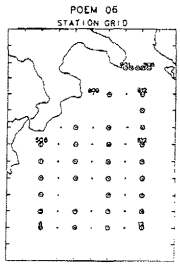

Fig. 1.
•: station with nutrients data

Typical dissolved oxygen profile is shown in Fig. 2. It exhibits a subsurface maximum (about µM) between 50 and 100 m. A wide water body with oxygen content of 190-200 µM lyes between 500 and 2.000 m. The minimum value is observed at about 1.000 m. In the deepest layer the oxygen content slowly rises up the value greater than 205 µM.

The nutrients distribution of the surface layer (0-150 m) is nearly homogeneous, exhibiting concentration values of 0.1, 0.05 and 1.0 µM for nitrate, phosphate and silicate respectively. Nutricline occures at about 150-200 m, corresponding to the oxygen minimum. Below 500 m, a wide, homogeneous region with the highest concentration values (nitrate: 5-5.5 µM; phosphate : 0.3-0.35 µM; silicate : 9-10 µM) extends as far as 2000 m, going on well with the oxygen minimum region. In the bottom layer concentration values go down as far as 4.5 µM, 0.15 µM, 8 µM for nitrate, phosphate and silicate respectively.

Distribution anomalies for all the investigated parameters were observed in the layer between 100 and 500 m. Fig. 3 shows both the location and the extension of these anomalies with respect to dissolved oxygen and nitrate, at 300 m.

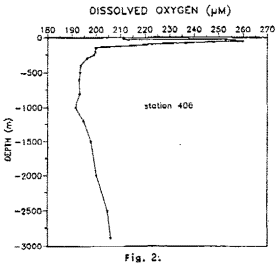

Fig. 2.

In Fig. 4 dissolved oxygen profiles of four stations along the transect at 37°N are reported. An increase of concentration is observed going to the middle of the transect, in particular the stations at the ends of the transect (406 and 412) results to ressemble each other much more than the central stations. Both this behaviour and the distribution anomalies shown in Fig. 3 could be attributed to the presence of gyres.

We can distinguish all over the basin :

a) the surface layer (0-150 m) characterized by the maximum concentration of oxygen, with oversaturation values, and the minimum concentration of nutrients. This layer can be interested by the diffusion of Atlantic water into the Ionian Basin;

b) the layer between 100 and 500 m characterized by the anomalies of the stations involved in cyclonic areas;

c) the wide layer between 500 and 2.000 m with th minimum oxygen content and the highest nutrients content, whose extension is the widest at the depth of 1.000 m where the water body spreads over the eastern half of the basin;

d) at last, the bottom layer influenced by the Adriatic waters and by the bottom circulation.

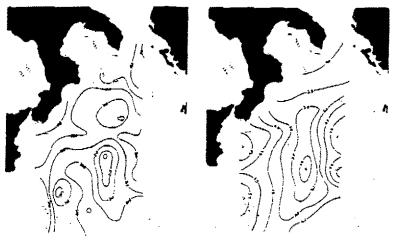

Fig. 3 : Dissolved oxygen (left) and nitrate (right) at 300 m.

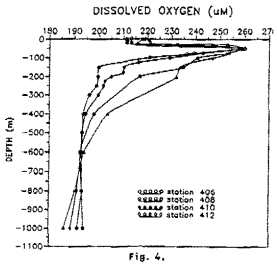

Fig. 4.

In conclusion, knowledge of the dissolved oxygen and nutrients distribution in the Ionian Basin has been considerably risen by the POEM Program results. In particular by the POEM 06 cruise, where a fine sampling was performed on the whole grid. From our results, peculiar chemical characteristics of Levantine Intermediate water (300-500 m) failed to point out. Whereas a water body (500-2.000 m) of Aegean origin is clearly recognizable below the LIW, however we don't have enough data to discuss its dynamic behaviour. In addition, the necessity of a finer sampling for the bottom water comes out from our work.

A model for the stable isotope characterisation of water masses in the Eastern Mediterranean Sea

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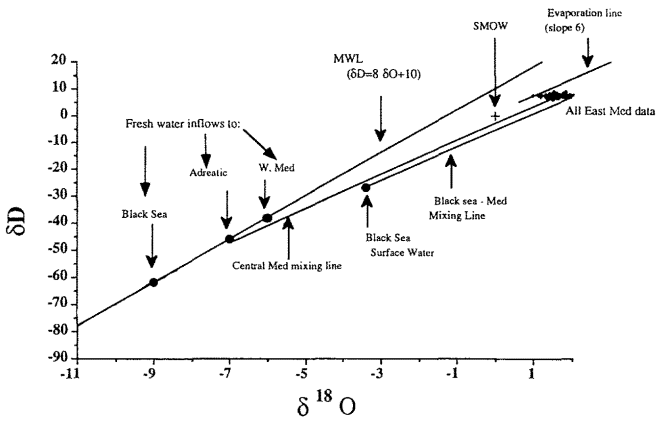
Water samples from thirteen hydrographic stations of the POEM program in the Eastern Mediterranean Sea were sampled July 1988 - March 1989 and analysed for their stable isotope content {$\delta^{18}O$ and δ^2H} and their tritium levels {TU}. Characteristic and distinguishable values are obtained for different water masses, with greater uniformity at depth and seasonal and spatial scatter in the surface waters. Averaged values were as follows:

depth (m)	mean salinity (‰)	$\delta^{18}O$ (‰)	δ^2H (‰)
below 1000	38.68	+1.505 ± 0.15	+7.64 ± 0.41
500 - 1000	38.80	+1.545 ± 0.19	+7.83 ± 0.46
50 - 400	38.94	+1.690 ± 0.15	+7.94 ± 0.35

The $\delta^{18}O$ values reported by PIERRE *et al.* (1986) for their hydrographic stations #10, 11, 14, 16 fall in line with these data, but the relationships between the enrichment of the oxygen and hydrogen isotopic species and of salinity differ from those found in other evaporative basins, i.e. the Red Sea (CRAIG, 1966) as well as in the western part of the Mediterranean (PIERRE *et al.*, 1986). In particular the relatively small enrichment of the deuterium is noted, with $\Delta\delta^2H/\Delta\delta^{18}O \sim 1.57$ compared to a value of 6 in the Red Sea. The value of $\Delta\delta^{18}O/\Delta S$ is found to be larger by a factor of two or three compared to a usual evaporative system, but the enrichment of the deuterated species is much reduced, i.e., $\Delta\delta^2H/\Delta S \to 0$.

This apparently anomalous pattern can be explained by the admixture of fresh waters through the Adriatic and Aegean (Black Sea) system. These continental fresh waters are depleted in the heavy isotopic species relative to the ocean waters.

A multi-stage model of evaporative enrichment followed by dilution with freshwater runoff seems to reproduce data rather well. Based on this model, the degree of admixture of freshwater runoff to the "evaporated" waters of the Mediterranean Sea can be specified.



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X

Nitrogen budget in the Eastern Mediterrenean Sea: results from a coupled 3D hydrodynamic-biological model

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The principal goal of the POEM 2 project is the interaction of the bio-geochemical cycles with the physical processes in the Mediterranean Sea. For this purpose a model was implemented, (CRISE *et al.*, 1992). Coupling the previously developed hydrodynamics (MALANOTTE-RIZZOLI and BERGAMASCO, 1989; PINARDI and NAVARRA, 1992) with a trophic model. In particular, the aim of this work is the discussion of the results of a numerical experiment devoted to the simulation of a simplified conservative nitrogen cycle. For this simulation, the Eastern Mediterranean is a well suited testbed because of the lack of significant nutrient sources and the Gibraltar effects have little influence on the eastern basins. Our model encompasses the whole Mediterranean and is based on a Bryan and Cox primitive equation eddy resolving mociel with a 1/4 degree spatial resolution and 16 levels in the vertical coordinate. This model is forced by monthly Hellermann wind stresses and is initialized by the Levitus climatological T-S data.

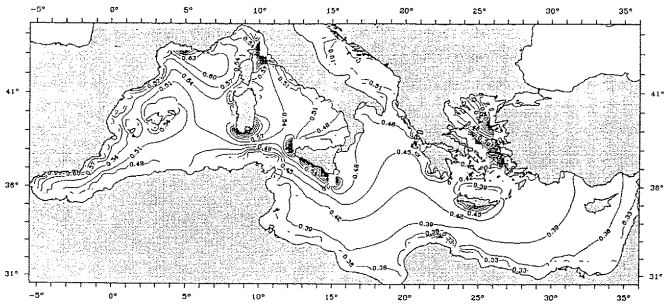

Fig . 1.- Nutrient distribution (*mg at N/m*3) at 50 meter depth in April

The biological model takes into account non-passive advection-diffusion of nitrogen, phytoplankcton and detritus on the same spatial grid of the hydrodynamic part, giving a good horizontal resolution. The considered limiting factors for phytoplancton growth are nitrogen concentration, downward irradiance and temperature. Climatic data arc used to initialize the biochemical fields; the daily irradiance and photoperiod are used as forcing terms for the biochemical model whereas the temperature and the advection evolve according to the hydrodynamic model.

The numerical results show a low nutrient concentration in the upper layer with an increasing concentration through the depth. The minimum is found in the Eastern Mediterranean while higher values appear in convergence areas, in good agreement with the known phenomenology. A snapshot of the model regarding nutrients is shown in fig. 1. An evaluation of nitrogen annual fluxes for Sicily Channel is estimated and comparisons with the figures given by BETHOUX (1981) are given.

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An Application of 'AQUAMOD' Trophic Model to the Marine Ecosystem along the Emilia-Romagna Coastal Region in the Adriatic Sea

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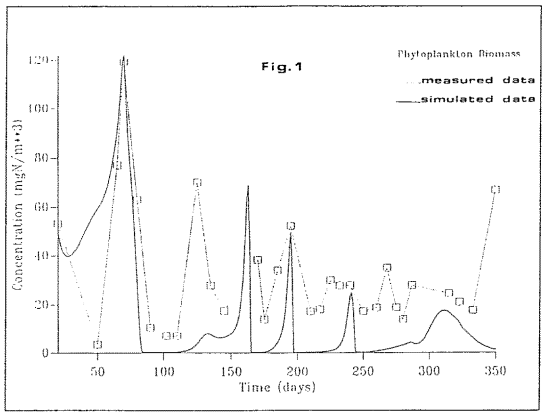
The trophic model 'AQUAMOD' (HULL and LAGONEGRO, 1988; LAGONEGRO *et al.*, 1991) has been applied for the first time to a coastal marine ecosystem. This model is able to simulate the dynamics of micro and macro-algae, macrophytes and zooplankton, giving also the fluxes of nutrients, oxygen, dissolved and particulate dead matter and sediments. The phytoplankton growth is limited by nutrient's concentrations, temperature and light.

By means of the existing data collected in the coastal sea of the Emilia Romagna Region, three groups of phytospecies (winter, spring-autumn and summer groups) have been taken into account in the model's equations. Two zooplankton species have also been introduced into the model: the first for describing the winter grazing, the second for the summer one.

The nutrient's concentrations and water temperature have been assigned through the measured data.

The model simulates the time evolution of the phytoplankton species and the zooplankton ones. The results have been compared with the measured values of chlorophyll *a*. Good correlations have been obtained between measured and simulated data.

In Fig. 1 the results of the simulation concerning the data collected at a station near Cattolica are reported.



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Observations on some biological properties in the upper layer of the Ionian Sea (POEM 06 Cruise, October 1991)

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In the frame of the POEM phase-II program, in interdisciplinary cruise was carried out in the Ionian Sea with the CNR RV "*Bannock*" from October 2nd to 24th, 1991; aside of the study on the physical oceanography of the Eastern Mediterranean Sea, which was the main goal of the POEM phase-I project, this cmise was more oriented to investigate the physical and chemical features of the Ionian basin, as well as the interactions wih the biological properties of the water masses. The station grid was choosen on the basis of the knowledge derived from the results of previous campaigns.

During the sampling period, the general circulation in the upper layer of the Ionian Sea (down to 200 m depth) was characterized by the presence of the Atlantic Water in subsurface waters: the AW flow, coming from the Sicily Strait, is easily identified by a salinity minimum (about 37.7 PSU) mainly at 50 m depth. This core streams in N-F. direction, crossing and spreading over a wide area in the Ionian Sea. The proper Ionian waters are characterized by salinity values ranging from 38.0 to 38.7 PSU.

Our aim was to evaluate if, front this hydrological pattern, some consequences on the distribution of the biological properties derive: for this purpose, in the following discussion, two stations were choosen as representative of different hydrological situations; st. 308, fully interested by the AW, and st. 112, out of the AW flow.

In st. 308 (fig. 1), the AW is located in a layer ranging from 30 to 75 m depth: the salinity minimun of 37.59 PSU is located at 50 m. Here, relative maxima in biological activity, like as bacteria and phytoplankton abundances, as well as particulated organic carbon (POC) and chlorophyll *a*, were found, which contribute to a maximum value of apparent oxygen utilization (AOU = -27µM). A deeper peak of *in-situ* fluorescence, obtained by a Sea-Tech fluorometer, was also observed; this behaviour can be ascribed entirely to the presence of phaeopigments, as shown by the highly significative correlation between all phaeo/fluorescence data ($r = 0.959$, $df = 52$).

In st. 112 (fig. 2), total bacteria and POC maxima were of served at the surface, while phytoplankton abundances were located between 20 and 50 m, associated with chlorophyll/phaeopigments ratios close to the unit and with a maximum value of AOU, both of them at 20 m. The maximun of *in-situ* fluorescence is between 100 and 120 m, once again strictly related to the maximum of chlorophyll degradation products.

These results let us to suppose that the Atlantic Water, streaming and meandering into the Ionian Sea characterized by a biological ativity higher than the upper or lower layers, while, outside of AW flow, from our observations the most active layer from the biological point of view is very close to the surface (0-20m).

Generally, the biological activity was rather poor in the whole basin, biomasses ranging frorn va]ues very close to zero (as chlorophyll *a* and particulated organic carbon regards) up to 0.2 µg dm 3 of Chl *a*, 4.8 µM of POC, and 36 10^4 cells ml^{-1} of total bacteria. The chlorophyll/phaeopigments ratios are mostly less than 1, indicating predominance of degradation products. Phytoplankton abundances range between 25 and 109 10^3 cells dm^{-3}. As the main taxonomic groups, weak is the contribution of diatoms, representing 6-7% of the total: this scarcity can be explained because of limiting silica concentrations (Si-SiO4 range = 0.5-5.9 µM; BREGANT, pers. comm.). The phytoplankton contribution to the POC varies with depth: from 0 to 50 m depth, the carbon fraction due to phytoplankton is 3-5%, from 50 to 100 m it increases up to 10-25%, while below 100 m it decreases again to 5% of the total. Consequently it appears that, in the surface layer, bacteria and detritus are the major suppliers to organic carbon, as verified by very high POC/Chl ratios (always < 100); below 50 m, the increase in phytoplankton biomass leads to a decrease of these ratios.

Even if in absence of informations about annual biological cycling in the Ionian Sea, these observations, together with the vertical pattern and their absolute values, let us to assess some preliminary conclusions:

- in the sampling period, the biological system was in a terminal growth phase, characterized mainly by low activities;
- the richness of organic carbon of the surface layer is mainly devoted to bacteria, while phytoplankton, generally located in a more deep layer, contributes only up to 25% to the total carbon;
- the methabolic products, associated to senescent cells (and probably to the grazing presure), sinked till the discontinuity layer.

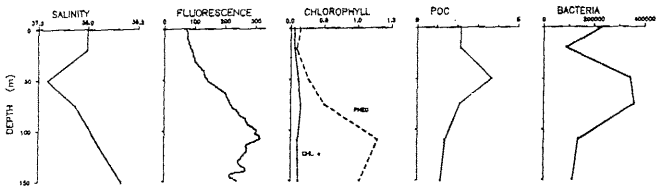

Fig. 1.- Vertical distribution of the studied parameters in st. 308, interested by AW.

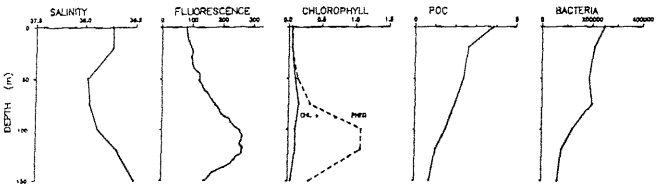

Fig. 2.- Vertical distribution of the studied parameters in st. 112, not interested by AW.