RAPPORT DU XXXIVE CONGRÈS DE LA COMMISSION INTERNATIONALE POUR L'EXPLORATION SCIENTIFIQUE DE LA MER MÉDITERRANÉE

Volume 34 1995

Sommaire

Des lettres-code sont affectées aux diverses réunions. Reportées sur la tranche du fascicule en blanc dans des carrés noirs, elles permettent de repérer aisément la section du volume correspondant aux travaux recherchés (voir page suivante).

A

SYMPOSIUMS ET COLLOQUES

A

REMOTE SENSING CAMPAIGNS OVER THE MEDITERRANEAN

V. BARALE

Institute for Remote Sensing Applications, Joint Research Centre of the European Commission, Ispra, Italy

In modern marine science, classical oceanographic campaigns are increasingly accompanied by remote sensing missions, which extend observations beyond the *in situ* platforms domain and sample the sea surface over a wide range of space and time scales. Such diverse techniques collect mutually exclusive but complementary data sets, all of which are required to properly assess marine phenomena (BARALE and MURRAY, 1992). If surface observations of bio-geo-chemical and physical parameters are performed simultaneously, process interactions can be addressed. And if the processes that generate the observed surface distributions can be determined, inferences based on *in situ* measurements can be made on subsurface properties.

The main features accessible to remote observations of the sea are essentially surface roughness and elevation, temperature and colour. In general, different methodologies may be applied, depending on the objectives and boundary conditions of the observations (ROBINSON, 1985). The structural properties derived from measuremets of surface roughness can contribute to the assessement of dynamical parameters such as winds, waves, wakes, and alterations of the water surface texture due to circulation features, to bottom profiles, or to the presence of surface films (e.g. hydrocarbons). Dynamical properties, expressed by the marine surface elevation with respect to the geoid, provide information on water motion and circulation at large planetary scales, or on deep geological features. Thermal properties, i.e. sea surface - skin-temperature, are related to phenomena of physical, dynamical or climatic nature. Currents, fronts, eddies, upwelling and vertical mixing events, as well as surface slicks of certain kinds, are some of the features described by the parameter temperature. Synoptic assessments of sea surface temperature are also important for circulation modeling, and for balancing energy exchanges at the air-water interface. Optical properties can be used to estimate ocean colour, i.e. 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 concentration of water constituents (i.e. planktonic pigments, degrading organic matter, such as the so-called yellow substance, or total dissolved and suspended matter in general). The remote assessment surface colour finds applications in the fields of marine biology and ecology at large, water quality and sediment transport, water circulation and dynamical processes - looking, e.g., at the evolution of pigment patterns and their distribution as related to circulation features, plankton dynamics or coastal runoff and river plumes - as well as in those of energy transfer, carbon cycling and climatology in general. Optical parameters can be used in the evaluation of primary production, which involves the combined knowledge of biomass estimates and a suite of auxiliary data on plankton distribution, properties and physiological state.

As for the concept of remote sensing oceanographic campaigns, a number of orbital sensors have shown their usefulness for providing information on the marine environment on a continuous basis. New perspectives for monitoring dynamics are emerging from the analysis of sea surface roughness data collected by the family of microwave (active) sensors carried by the European satellite ERS-1 - which is the heir of the extremely successful, but short lived, 1978 SEASAT mission and of the GEOSAT mission of the mid 1980's. Optical remote sensing, of coastal zones primarily, has been based historically on high-resolution (pixels on the order of 10's of meters) data collected in the visible/infrared spectral region - e.g. by sensors like the Thematic Mapper (TM), on board the LANDSAT satellites, and the Haute Resolution Visible (HRV), on board the satellite SPOT. However, remote sensing of sea surface colour and temperature, conducted by means of low-resolution (pixels on the order of 1000's of meters) data collected in the visible/infrared and thermal infrared spectral regions, has provided the most interesting data sets for oceanographic applications. Sensors like the Advanced Very High Resolution Radiometer (AVHRR), on the NOAA/TIROS satellite series, and the Coastal Zone Colour Scanner (CZCS), on board Nimbus-7, have assembled outstanding multi-year time series of such data in the 1980's for most of the world's oceans and for the Mediterranean basin as well.

The latest release of an historical archive, which can be considered an oceanographic campaign in its own right, concerns the data set generated by the CZCS, starting in late 1978. The sensor, designed for a proof-of-concept mission that should have lasted only one year, continued to be operated and to collect data on selected oceanic test sites until early 1986, ultimately generating a unique time series of data on the optical properties of the world's ocean surface waters. To this day, the CZCS remains the only ocean colour instrument to have been successfully placed and operated in Earth orbit. The exploitation of the CZCS historical time series is still in progress and will continue to provide a significative statistical reference to future ocean colour assessments.

A complete European CZCS historical archive has been generated in the framework of the Ocean Colour European Archive Network (OCEAN) Project (BARALE, 1994). The data set covering the Mediterranean Sea and the Black Sea has been used to explore relatively clear, oligotrophic, pelagic regions as well as dynamic, mesotrophic, at times even eutrophic, near-coastal areas and marginal basins. Various fully processed data products are available, including water classification parameters, marine and aerosol reflectances and pigment concentrations systematically remapped, using an equal-area projection, to a standard geographical grid with constant resolution of 1 km. The temporal coverage, in the 1979-1985 period, includes daily, monthly, seasonal and annual time scales. The bio-optical data base collected by the CZCS is integrated by a number of ancillary data sets (meteorological data, ozone concentration, etc.) used to derive value-added information. Corresponding time series of sea surface temperature derived from historical AVHRR data are also available. The data have been processed and archived in support of current research activities, as well as with the aim of preparing suitable tools and structures for the exploitation of future space missions with optical instrumentation (BARALE and SCHLITTENHARDT, 1994).

REFERENCES

BARALE V., 1994. Mediterranean Colours, *La Lettre de la CIESM*, Septembre 1994.

BARALE V. and MURRAY C.N., 1992. Space observations and Geographic Information Systems : the marine environment case. *Fresenius Environ. Bull.*, 1, 655-660.

BARALE V. and SCHLITTENHARDT P.M., 1994. Monitoring the marginal seas of Europe with optical observations, *in* : Remote Sensing - from Research to Operational Applications in the new Europe, R. Vaughan ed., Springer-Verlag, Budapest, 293-298.

ROBINSON I.S., 1985. Satellite Oceanography : an introduction for oceanographers and remote sensing scientists, Ellis Horwood Ltd, Chichester (UK).

TWO DECADES OF DEEP-SEA DRILLING IN THE MEDITERRANEAN : PAST, PRESENT AND FUTURE

Maria Bianca CITA

Dipartimento di Scienze della Terra dell'Universtà di Milano, Italia

The geological history of the Mediterranean region is very complex and articulated. The Mediterranean sea, as we know it now, consists of two major parts : the western Mediterranean which was formed in post-alpine orogeny time and the eastern Mediterranean which is much older and is considered a remnant of Mesozoic Tethys.

Deep Sea Drilling had a fundamental impact in the scientific exploration of the Mediterranean, with special reference to its evolution in the Neogene (last 24Ma).

The past.

1970. The first drilling campaigns (leg 13 of the Deep Sea Drilling Project) was extremely successfull. Even though in the early days of the project core recovery was not comparable to the present one, and site survey was primitive in many occasions, fourteen drillsites were successfully drilled and cored to a subbottom penetration up to 800 m. The most exciting result was the discovery that in all the major basins explored (Alboran, Balearic, Tyrrhenian, Ionian and Levantine), under a one to several hundred meters thick sedimentary cover consisting of oozes, marls and turbidites of Plio-Pleistocene age, Messinian evaporites were present, indicating subtidal, intertidal and even supratidal conditions. This discovery leads to develop the concept of Mediterranean salinity crisis, and to the formulation of the so-called "deep basin desiccation model".

1975. The second drilling campaign (leg 42A od DSDP) provided additional evidence for the desiccation model by (a) recovering pre-Messinian sediments indicative of open marine deep water conditions both in the western Mediterranean (DSDP site 372, Balearic Basin) and in the eastern Mediterranean (DSDP site 375, Levantine Basin), (b) documenting intertidal to supratidal facies in the Messinian evaporites recovered from the deepest basin of the Mediterranean (i.e. Messina A.P. - 4200 m) and (c) recovering Messinian evaporites in the Aegean sea, north of Crete. Among the most interesting results is the first recovery of basement rocks from the Tyrrhenian sea (DSDP site 373, flank of seamount).

1986. The third Mediterranean drilling campaign (leg 107 of the Ocean Drilling Project) was centered on the Tyrrhenian sea. A transect of seven holes aligned NW-SE across the back arc-basin proved beyond any doubt that its evolution was quite recent and fast, as fast as that of recently explored back-arc basins of the West-Pacific. The main results include : recovery of basement rocks at four drillsites, one with peridotites; first good paleomagnetic calibration of the Plio-Pleistocene succession, discovery of a 500 m thick pile of subaqueous, but non marine (lacustrine) Messinian sediments in the western Vavilov basin; demonstration that the age of marine sediments overlying basement is progressively younger from the western end of the transect (passive margin of Sardinia) to the eastern end (Marsili basin).

Present and future.

A new phase of exploration will start soon and has three major objectives; two of them essentially dealing with the tectonic evolution of the Mediterranean, the third one with paleoceanographic circulation and evolutionnary patterns. One of the tectonic themes deals with the Alboran basin. By drilling a series of holes it is hoped to decipher the extensional history of this basin which is entirely surrounded by orogenic chains. Another tectonic theme is concerned with the Mediterranean Ridge, an accretionary complex in collisional context. The subducting sediment pile is anomalously thick and contains at shallow subbottom depth the Messinian evaporites. As a result of the combination of all these factors, mud diapirism is highly developed.

The 1995 drilling plan includes a transect of (shallow) holes across an active mud volcano, an experiment never undertaken so far. This tectonic objective will be combined with a transect of holes across the Eratosthenes Seamount south of Cyprus, of great geodynamic interest.

The third theme is focused on "Mediterranean sapropels". Sapropels are pelagic, organic-rich sediment layers well known from the late Quaternary of the eastern Mediterranean, poorly known elsewhere. Their origin is controversial with basically two alternatvie models : one relating them to the vertical stratification of the water column, the other one oriented to changes in productivity. The experiment consists in continuous coring (twice or three times, in order to guarantee a complete recovery) 7 drillsites along an E-W transect crossing the entire Mediterranean, where temperature and salinity gradients are known.

The three scientific themes have been combined in two drilling legs (ODP 160+161) for logistic reasons,dealing respectively with the western Mediterranean (the latter) and the eastern Mediterranean (the former). Never before four consecutive months of shiptime were dedicated to the Mediterranean !

We look forward seeing the new results and we do hope they will bring the same scientific excitement that the previous Mediterranean drilling campaigns brought about. But this will by no means be the end of the scientific exploration of the Mediterranean by deep drilling. Indeed, the present step of exploration only comprises shallow targets. Deep targets are not obtainable with the present technology which prevents the penetration of the Messinian avaporites without a riser. If such technology will be made available in the future, a brand new scenario for deep drilling will open ahead of us.

EROS 2000 (EUROPEAN RIVER OCEAN SYSTEM) : AN OVERVIEW

Jean-Marie MARTIN

Institut de biogéochimie marine, URA CNRS 386, Ecole normale supérieure, 1 rue Maurice Arnoux, 92120 Montrouge, France

The EROS 2000 project is an attempt to understand the biogeochemical processes affecting chemical elements and compounds and their alteration by human activities in European coastal waters. During the first phase of this project, eight major cruises onboard research vessels belonging to seven countries of the European Union were carried out in the western Mediterranean. Special attention was paid to the Gulf of Lions, the Straits of Sicily anf Gibraltar and the central western Mediterranean. Major rivers such as the Rhone and the Ebro have been monitored and a network of atmospheric sampling stations has been implemented.

This lecture will mainly focus on results concerning trace metals (T.M.) and artificial radionuclides. Key examples will be given so as to examply the following aspects :

i. Relative importance of the various sources of T.M to the western Mediterranean. The dissolved input of atmospheric trace elements (Pu-238 excepted) is larger than the river input, however for most T.M, the fluxes at the Straits prodominate.

ii. Most T.M behave conservatively in the estuarine mixing zone, a result conflicting with most observations carried out in macrotidal estuaries.

iii. Examples of T.M exceeding natural concentrations are given indicating some clear perturbation of man-made origin. For some elements (Zn, Pb) the system is no more at steady state.

iv. The significance of total dissolved concentration measurements is challenged. The role of colloidal phase is highlighted.

v. The distribution of mercury species gives some new insight in the understanding of the very high mercury levels measured in some pelagic fishes of the Mediterranean.

vi. Some examples of input-output budgets of T.M. show a remarkly well-balance situation.

REFERENCES

D. COSSA, J.-M. MARTIN and J. SAN JUAN (1994). Dimethyl mercury formation in the Alboran Sea. *Mar. Poll. Bull.*, 28 : 391-394.

F. ELBAZ-POULICHET, J.-M. GARNIER, D. M. GUAN, J.-M. MARTIN and A.J. THOMAS. Riverine variability and estuarine conservativity of trace elements in the Rhone river Delta, France. *Est. Coast. Sh. Sci.*, in press.

M.H DAI, J.-M. MARTIN and G. CAUWET. Significant role of colloids in the transport and transformation of organic carbon and trace metals in the Rhone Delta, France. *Mar. Chem.*, in press.

C. GIUEU, J. ZHANG, A. J. THOMAS, J.-M. MARTIN and J.-C. BRUN-COTTAN, 1993. Siginificance of atmospheric fall-out on the upper layer water chemistry of the North western Mediterranean. *J. Atm. Chem.*, 17 : 45-60

THE "EGAMES" EXPEDITION IN THE EASTERN MEDITERRANEAN SEA

S. RAPSOMANIKIS[1], H. BANGE[1], V. ULSHOEFER[1], O. FLOECK[1], T. KENNTNER[1], D. AMOUROUX[2], O. F. X. DONARD[2], J. ENGLEZOU[3], V. TSELENTIS[4] and I. CIGLENECKI.

[1] Biogeochemistry Depart., Max Planck Inst. for Chemistry, 55020 Mainz, Germany
[2] Lab. de Photophysique et Photochimie Moléculaire, CNRS, Univ. de Bordeaux, 351 Cours de la Libération, 33405 Talence Cedex , France
[3] Depart. of Maritime Studies, Univ. of Piraeus, Karaoli & Dimitriou 40, 185 32, Greece
[4] Rudjer Boskovic Institute, Center for Marine Research, P.O. Box 1016, 41001 Zagreb, Croatia

A

The expedition EGAMES (**E**vasion of **GA**ses from the **ME**diterranean **S**ea) took place in the eastern Mediterranean Sea during July 1993 with the aim to study fluxes of climatic relevant gases to the atmosphere, during a period of high insolation and to establish the region's contribution to the global budget of these gases. A number of physical and chemical parameters necessary for the calculation of these fluxes were also measured.

The continuous CTD recordings during the cruise track indicate that four distinct areas were studied. The northern Aegean, which is influenced by incoming Black Sea waters, the open Aegean and Ionian Seas, an upwelling area and an enclosed bay. The recorded meteorological data showed north westerly winds throughout the cruise.

Surface waters fluorescence recordings suggest generally photobleached Chromophoric Dissolved Organic Matter (exudates and humics). The CDOM stratification depends on the mixed layer depth. Humic material was observed mainly in the Black Sea influenced waters, whilst biogenic exudates were mainly observed in the eutrophic bay and the upwelling waters (DONARD *et al.*, 1989)

Results of the analyses of surface waters for H_2O_2 indicate high photochemical reactivity. The average $[H_2O_2]$ was ca. 250 nmol/l, which suggests a high concentration of reactive oxygen species (AMOUROUX *et al.*, 1993)

Our measurements, of surface sea waters for carbonyl sulfide (COS) concentration and *in situ* production, show that they were always supersaturated with respect to the equilibrium concentration, based on the atmospheric COS mixing ratio. The mean saturation ratio was 3.2. Average COS water concentrations were 27 +/- 16 pmol/l and varied diurnally. With an atmospheric mixing ratio of 523 +/- 107 pptv a positive sea to air flux of 55 nmol/m^2/day could be estimated for the area studied. *In situ* production experiments using collected water samples indicate a photoproduction of COS with concurrent decline in $[CH_3SH]$ (ULSHOEFER *et al.*, 1994).

High CH_4 saturation ratios were observed in the Black Sea influenced north Aegean and in the eutrophic bay waters (1.4 - 5.2). Saturation ratios of N_2O were uniform throughout the cruise at 1.05. Atmospheric concentrations of both CH_4 and N_2O remained practically constant during the course of the cruise (BANGE *et al.*, 1994).

A number of different Se species were identified in surface sea waters and in the atmosphere; namely $(CH_3)_2Se$, CH3SeH, and $(CH_3)_2Se_2$. Their concentrations were higher in the eutrophic bay than in the upwelling area which in turn were higher than in the oligotrophic waters. The degree of saturation was on the average higher than 10.0 , giving an estimated, positive, sea to air flux for the area, of 20 nmol Se /m^2/yr.

Sulphur dioxide atmospheric mixing ratios of eastern Mediterranean marine air, ranged between 10 - 200 pptv. Surface sea water concentrations of $(CH_3)_2S$ averaged at 3 nmol/l (RAPSOMANIKIS *et al.*, 1994)

Surface water samples were also analysed, using an electrochemical method, for surface active substances and their activity is expressed in units of "Triton-X-100" mg/l (PLAVSIC *et al.*, 1993). The mean surfactant activity for surface samples was 0.122 mg/l as T-X-100 which is comparable with Adriatic Sea values for the summer of 1992. The preliminary results show that more hydrophobic organic material was present in the Aegean Sea than in the turbulent waters of the Levantine or the open sea.

A number of other atmospheric and meteorological parameters were also measured, to help us in our biogenic fluxes estimations.

REFERENCES

AMOUROUX D. and DONARD O.F.X., 1994. Hydrogen peroxide determination in estuarine and marine waters by flow injection with fluorescence detection. *Oceanologica Acta*, in Press.

DONARD O.F.X., LAMOTTE M., BELIN C. and EWALD M., 1989. High-sensitivity fluorescence spectroscopy of Mediterranean waters using a conventional or a pulsed laser excitation source. *Mar. Chem.*, 27 : 117-136.

BANGE H.W , RAPSOMANIKIS S. and ANDREAE M.O.A., 1994. The Aegean as a source of atmospheric nitrous oxide and methane. *Mar. Chem.*, Submitted.

RAPSOMANIKIS S., Gimm H. and Andreae M.O.A., 1994. Fluxes and oxidation products of dimethylsulfide in the Eastern Mediterranean Sea. *Mar. Chem.*, Submitted.

PLAVSIC M., VOJVODIC V. and COSOVIC B. Characterisation of surface active substances during a semi-field experiment on a phytoplankton bloom. *Anal. Chim. Acta*, 232 : 131-140.

ULSHOEFER V.S., FLOECK O. R., UHER G. and ANDREAE M.O.A., 1994. Photochemical production and air-sea exchange of carbonyl sulfide in the Eastern Mediterranean Sea. *Mar. Chem.* Submitted.

FLUXES OF DISSOLVED AND PARTICULATE TRACE ELEMENTS AT THE STRAITS OF GIBRALTAR AND SICILY

R. WOLLAST[1], D. BURTON[2], J.-M. MARTIN[3], C. M. G. VAN DER BERG[4]
L. CHOU[1], H. PAUCOT[1], N. MORLEY[2], S. TANKERE[2], W. W HUANG[3]
Y. Y. YON[3], M .H. COTTÉ[3], E. P. ACHTERBERG[4], M. GLEDHILL[4]

[1] Université de Bruxelles, lab. d'Océanographie chimique, Brussels, Belgium
[2] University of Southampton, Depart. of Oceanography, United-Kingdom
[3] Ecole normale supérieure, Inst. de biogéochimie marine, Paris, France
[4] University of Liverpool, Oceanography lab., Liverpool, United-Kingdom

A

During the European River Ocean System programme (EROS 2000), intensive measurements of the distribution and fluxes of dissolved and particulate trace elements were performed within the western Mediterranean sea as well as at the boundaries of the system (river, atmosphere, sediment, straits). This exceptional set of data allowed one to extablish a coherent mass balance for the system.

Two cruises performed during the Valdivia and Discovery were especially devoted to the determination of the vertical distribution of dissolved and particulate metals along small transects crossing the Straits of Gibraltar and Sicily. Various hydrodynamical models were tested in order to evaluate exchange fluxes between the western Mediterranea sea, the North Atlantic and the eastern Mediterranean sea. The water fluxes suggested by BETHOUX (1980) were selected here.

The relative importance of the exchanges at the straits will be compared to the riverine and atmospheric fluxes at the boundaries of the system for the following elements : Al, Cr, Mn, Fe, Co, Ni, Cu, Zn, Pb.

REFERENCES

BETHOUX J.-P., 1980. Mean Water fluxes across sections in the Mediterranean sea, evaluated on the basis of water and salt budgets and of observed salinities. *Oceanologica Acta*, 3, 1 : 79-88.

A

XIIe colloque
PAM-PNUE/CIESM sur les pollutions marines en Méditerranée

C1. L'impact écologique des pollutions accidentelles par les hydrocarbures.

C2. L'utilisation des biomarqueurs dans l'évaluation des pollutions marines.

A

IMPOSEX AS A BIOMONITORING TOOL OF CONTAMINATION BY TBT IN THE MEDITERRANEAN

Victor AXIAK
University of Malta

Environmental monitoring within the Mediterranean is essentially based on chemical analysis of a range of suspected pollutants. The limitations and inadequacies of the present chemical monitoring programme have been identified by JOANNY (1990). Analytical problems and difficulties of interpretation of data are further compounded when dealing with certain pollutants which exert their biological effects at extremely low environmental levels. These include a specific organotin (Tributyltin, TBT) which has been used as an antifouling biocide on marine craft.

Elevated levels of TBT and its degradation products have been recently reported in the Mediterranean (GABRIELIDES *et al.*, 1990). Such pollutants may cause harm to inshore species (including economically important organisms such as oysters) at very low concentrations. The present author believes that a biomonitoring programme based on the use of imposex as a bioassay, is the only monitoring strategy which at present may provide data which is sufficiently reliable and which may cover the whole Mediterranean region at minimal costs.

Imposex is the imposition of male genitalia (penis and/or vas deferens) on females in certain marine prosobranchs. FIORONI *et al.* (1991) list 69 species of 46 genera of prosobranchs in which this phenomenon has been identified. At present there is a near-general consensus that no xenobiotic other than TBT is known to cause imposex in such species. A number of TBT-biomonitoring programmes based on the use of imposex have been successfully conducted in a number of regions, such as in U.K. using *Nucella lapillus*, and in North America using *Ilyanassa obsoleta*. More recently, this bioassay has been used in field biomonitoring of TBT contamination in Malta, using *Hexaplex* (Murex) *trunculus* (AXIAK *et al.*, in press). This species has proved to be one of the most sensitive in its imposex response to TBT, of all species investigated so far.

The degree of imposex may be quantified by various indices, including: the Relative Penis Size Index (RPS) which is the ratio between the cubed mean penis length in imposexed females to that in males for a given population; and the Vas Deferens Sequence (VDS) Index, whereby imposex development is divided into various stages of vas deferens development, with each stage being given a score. The vas deferens sequence may vary according to species (FIORONI *et al.*,1991).

While imposex indices are always strongly correlated with proximity to marinas or harbours, in several reported cases the mean TBT body burdens for exposed population are found to be correlated with imposex indices, only at extremely low levels of TBT. This is because imposex induction occurs at levels as low as 1 ng Sn l^{-1}. Imposex is generally induced over a period of 6-12 weeks (eg. GIBBS *et al.*, 1991). Furthermore it is apparently an irreversible phenomenon, and may be found in populations where TBT contamination is no longer present. For example, when *H. reticulata* affected by imposex was kept for 18 months under TBT-free conditions in the laboratory, no evidence for imposex remission was found (STROBEN *et al.*, 1992).

Imposex may lead to sterility and preferential female mortalities in some species such as *Ocenebra aciculata* and *Nucella lapillus* (GIBBS *et al.*, 1988). In *Nucella* normal egg capsule production occurred only in females held at a TBT concentration of 1-2 ng Sn/l; at higher TBT levels females were sterilised by imposex. Oogenesis was suppressed at TBT levels above 3-5 ng Sn/l to be supplanted by spermatogenesis leading to sperm production. The decline (and in some cases, complete eradication) of populations of *Nucella*, in U.K., France and Norway, during the past decade, has been well documented. More recently, as a result of the enforcement of TBT-controlling regulations, recovery of some of such populations has also been successfully monitored through imposex biomonitoring (eg. EVANS *et al.*, 1994).

Apparently, imposex is related to an increase in testosterone titre in exposed females in response to exposure to TBT (SPOONER *et al.*, 1991). LEE (1991) has suggested that the cytochrome P-450 dependent mono-oxygenase system is mainly responsible for the elimination of TBT from the body of marine organisms. Moreover, MFO activity is important in steroid metabolism. The susceptibility of molluscs to TBT (including imposex in prosobranchs) may be related to their relatively low MFO activities. In any case, the exact molecular basis of imposex has still to be determined. It is concluded that if properly calibrated, imposex in a limited number of species, may be successfully used for TBT biomonitoring over the whole Mediterranean due to the high sensitivity and specificity of this response, as well as the low-costs involved.

REFERENCES

AXIAK V. VELLA A.J., MICALLEF D., CHIRCOP P. and MINTOFF B. Imposex in *Hexaplex trunculus* : First results on biomonitoring of TBT in the Mediterranean. *Marine Biology*. In press.
EVANS S.M.,, HAWKINS S.T., PORTER J., SAMOSIR A.M., 1994. Recovery of dogwhelk populations on the Isle of Cumbrae, Scotland following legislation limiting the use of TBT as an antifoulant. *Mar. Pollut. Bull.* 28 : 15-17
FIORONI P., OEHLMANN J. and STROBEN E., The Pseudohermaphrodism of Prosobranchs; Morphological aspects. *Zool. Anz.* 226(8): 1-16.
GABRIELIDES, G., ALZIEU, C., READMAN, G.W., BACCI, E., ABOUL-DAHAB, O., and SALIHOGLU I., 1990. MED POL Survey of organotins in the Mediterranean. *Mar. Pol Bull.* 21(5):233-237.
GIBB, P.E., PASCOE P.L., BURT G.R., 1988. Sex change in the female dog-whelk, *Nucella lapillus*, induced by tributyltin from antifouling paints. *J. Mar. Biol. Assoc.* U.K. 68 : 715-731
GIBBS P.E., BRYAN G.W., PASCOE P.L., 1991. TBT-induced imposex in the dogwhelk, *Nucella lapillus* : Geographical uniformity of the response and effects. *Mar. Environ. Res.* 32 : 79-87.
JOANNY M., 1990. Monitoring Strategies of Marine Pollution. Xth Workshop on Marine Pollution in the Mediterranean, Perpignan. Rapp. Com. Int. mer Médit., 31(1) :119
LEE R.F., 1991. Metabolism of tributyltin by marine animals and possible linkages to effects. *Mar. Environ. Res.*, 32 : 29-35
SPOONER N., GIBBS P.E., BRYAN G.W., GOAD L.J., 1991. The effect of tributyltin upon steroid titres in the female dogwhelk, *Nucella lapillus*, and the development of imposex. *Mar. Environ. Res.* 32 : 37-49.
STROBEN E., OEHLMANN J., FIORONI P., 1992. The morphhological expression of imposex in *Hinia reticulata* (Gastropoda: Buccinidae): a potential indicator of tributyltin pollution. *Mar. Biol.* 113 : 625-636.
(Note: A full bibliography list will be made available during the presentation.)

BIOREMEDIATION OF AN OIL POLLUTED BEACH

Eliora Z. RON[1], Rachel LEGMANN[1], Ariel KUSHMARO[1]
Ellik ADLER[2] and EugeneROSENBERG[1]

[1]Department of Molecular Microbiology and Biotechnology, The George S. Wise Faculty of Life Sciences, Tel-Aviv University, Tel-Aviv, Israel
[2]Marine and Coastal Environment Div., Office of the Environment, Jerusalem, Israel

Bioremediation of oil pollution in open systems presents several problems (BARTHA, 1990; GLASER, 1991; ROSENBERG, 1991). These include :
1. The long period required for biodegradation
2. Difficulties in making available a supply of nutrients, mainly nitrogen and phosphorus compounds, which dilute rapidly and become inaccessible.
3. The biological solutions have not been suitable for immediate emergency response.

We have been developing a novel technology for treating oil pollution in open systems - at sea, fresh water (lakes, ponds and rivers) and on beaches. The basis for this procedure is the combined use of specific bacterial strains that adhere to hydrocarbons (ROSENBERG & ROSENBERG, 1985; ROSENBERG, 1991) and a unique oleophilic, controlled-release, nitrogen and phosphorous source.

This technology was used for the bioremediation of the north beach of Haifa (30,000 m^2) following an oil spill of several hundred tons of heavy crude oil. The rate of oil degradation was 0.13 mg per gram sand per day in the summer (25°C), and half this rate in the winter (less than 10°C). The major treatment took place in the winter and was completed in four months. It should be noted that the winter was unusually hard, and temperatures were around 5-10°C for a couple of months. At the end of the treatment about 90% of the oil has been degraded, and this included the heavy (up to C40) as well as the aromatic fractions of the oil.

Visual examination of the beach sand following the treatment, in addition to the analytical data described above, indicated that this technology was applicable for bioremediation of the sand, that also became light in color.

Biodegradation of hydrocarbon-contaminated sand at Haifa beach during summer and winter

% Biodegradation	August		January	
Day	Natural	Treated	Natural	reated
0	0	0	0	0
4	0	30		
9	18	50	11	25
14	26	77		
25	15	85	25	50
38			5	66
87			0	80
123			5	89

The initial concentration of hydrocarbon-contamination in the in the upper 10 cm of sand of the control plot was 2.3 mg/g sand and 3.8 mg/g sand in the experiment. The average standard deviation was 0.15 mg/g sand.

REFERENCES

BARTHA R., 1990. Bioremediation potential of terrestrial fuel spills. AEM 56 : 652-656
GLASER JA., 1991. Nutrient-enhanced bioremediation of oil-contaminated shoreline: The Valdez experience. *In :* Hinchee RE, Olfenbuttel RF (Eds) On Site Bioreclamation (pp 336-384). Butterworth-Heinemann, Stoneham.
ROSENBERG E., 1991. Hydrocarbon-oxidizing bacteria. *In* :Ballows, A (Ed) The Prokaryotes (pp441-459) Springer-verlag, Berlin
ROSENBERG M. & ROSENBERG E., 1985. Bacterial adherence at the hydrocarbon-water interface. *Oil & Petrochem Pollution,* 2 :155-162

POSSIBLE UTILIZATION OF METALLOTHIONEIN AS A STRESS INDEX IN BIOMONITORING PROGRAMS

Aldo VIARENGO

Dipartimento di Scienze e Tecnologia Avanzate, Università di Torino, II Facoltà di Scienze M.F.N. Via Cavour 84, Alessandria, Italy

A

In recent years, the utilization of stress indices has been proposed to evaluate the effects exerted by pollutants on marine organisms. In fact, it has been demonstrated that pollutants, such as heavy metals and organic xenobiotic compounds, can produce modifications of biochemical and physiological processes in the contaminated organisms. These alterations can be quantified by estimating the value of biological parameters whose variations may be related to the physiological status of the animals (BAYNE *et al.*, 1988; VIARENGO and CANESI, 1991).

Scope for growth, lysosomal membrane stability, hystopathological alterations, DNA damage and stress proteins are among the general stress indices which reveal a stress syndrome characteristic of the response of organisms to a wide range of environmental stressors. Among the specific stress indices, reflecting responses to particular classes of contaminants, have been considered of particular interest i.e. the activity of the mixed function oxygenase system, which reveals the response of marine organisms to organic xenobiotic pollution, the acetilcolynesterase activity, which reveals the organophosphate and the carbamate insecticide pollution, the induction of imposex, utilized to reveal TBT (Tributyltin) contamination and the level of metallothioneins utilized as an indicator of the presence of heavy metals in the marine environment, which, as is known, are among the most important pollutant in coastal areas.

The evaluation of the level of metallothioneins in marine organisms has been proposed for monitoring the effects of heavy metals, since these proteins represent a response of the organisms to pollution by heavy metals such as Cu, Zn, Cd, Hg. In fact, it is well known that the enhancement of heavy metal concentration in the cells stimulates the "de novo" synthesis of metallothioneins that bind metal cations in a non-toxic form thus reducing their deleterious effects (VIARENGO and NOTT, 1993).

Utilizing the current methodologies the levels of metallothioneins can be measured with HPLC-AAS analysis or HPLC-ICP to evaluate heavy metal cations bound to metallothioneins; electrochemical and radioimmunological procedures, metal substitution assay are often utilized for the analysis of metallothionein concentrations in the cells (VIARENGO and NOTT, 1993). These procedures are often too sophisticated to be used for routine analysis of many biological samples. Recently two new methodologies for the quantification of the metallothionein concentration in the tissues of marine organisms have been developed i.e. a spectrophotometric and an electrophoretic/fluorimetric procedure. Both methods are simple, low-cost, time-saving and highly sensitive so that they could be routinely utilized in biomonitoring programs, also in those laboratories not provided with highly sophisticated instruments.

REFERENCES

BAYNE B.L., CLARKE K.R. and GRAY J.S., 1988. MEPS Special - Biological effects of pollutants: Results of a pratical workshop, *Mar. Ecol. Progr. Series*, 46 : 1.

VIARENGO A. and CANESI L. 1991. Mussels as biological indicators of pollution. *Aquaculture*, 94 : 225-243.

VIARENGO A. and NOTT J.A. 1993. Mechanisms of heavy metal cation homeostasis in marine invertebrates. *Comp. Biochem. Physiol.*, 104C, 3 : 355-372.

A

Modélisation interdisciplinaire des processus biogéochimiques
(MAST/MTP)

NUTRIENT AND METAL BEHAVIOUR IN THE MEDITERRANEAN SEA, DEDUCED FROM BOX-MODEL

J.-P. BETHOUX and D. RUIZ-PINO

LPCM, Université Paris 6, CNRS/INSU, BP8, F06230 Villefranche/Mer, France

In the Mediterranean Sea, the succession of deep inner basins, filled with homogeneous dense waters, facilitates budgets of chemical elements, including natural and anthropogenic inputs from Atlantic, atmospheric and terrestrial sources and transfer processes. In the frame of GEODYME (GEOchemistry and DYnamics of the MEditerranean, a Mast II/MTP sub-project) and of its preliminary studies, box-models were used to quantify the external inputs of nutrients and trace-metal and the marine transfers via biological activity, marine dynamics and sedimentation. The used circulation scheme was based on heat, water and salt budgets (BETHOUX, 1980) and improved by results from geochemical tracers such as tritium, oxygen and trace metal (BETHOUX, 1989; RUIZ-PINO *et al.*, 1990, 1991). At a basin scale, it gives horizontal and vertical motions which are not open to direct measurement and not yet estimated by general circulation models (GCM). In winter, vertical transfers are increased by dense water formations in the Levantine Basin, Aegean and Adriatic Seas and in the northern part of the Western Basin. In other seasons, biological activity is the main factor influencing the vertical transfer of matter from the surface to the deep waters. At a basin scale, new production may be estimated from nutrient or oxygen budgets (e.g. BETHOUX, 1989) or from satellite imagery when sea surface colour is converted into biological production and when the f ratio (new versus total production ratio) is known (e.g. MOREL and ANDRE, 1991). Dense water formation and intense horizontal and vertical circulations give a quite short residence time of deep water in the Algero-provençal basin (about 10 to 15 years) and, in the surface layer, water movements and biological transfers give a residence time of a few years. These short residence times favor the detection of changes in the physical and chemical characteristics of sea water and the monitoring of the environmental changes. Effectively, in the Western Mediterranean, evolutions of deep-water concentrations (phosphate and nitrate data) or comparison of surface and deep concentrations (trace metal), quite different from those encountered in the great oceans, obliged to consider non-steady-state behaviour and allowed to quantify changes in the Mediterranean environment, at yearly time scale and basin scale. Such a monitoring, from marine measurements, of an evolutive environment is quite a peculiarity and an advantage of the Mediterranean Sea.

The increases of deep-water concentrations prove that the anthropogenic inputs from terrestrial and atmospheric sources definitively exceed the Antlantic and natural inputs. As a result from a six-box model, the measured increases of phosphate and nitrate in deep western water, at rates of about 0.5% a year since the early sixties, is converted into an increase of anthropogenic inputs at a rate of about 3% a year. The probable consequences are : i) an increase of biological production in surface and coastal waters, ii) an increase of oxygen consumption in deep water for the remineralization of the settling organic matter. From trace metal data, input increasing rates were estimated equal to about 6% a year for zinc and 2% a year for cadmium and copper (BETHOUX *et al.*, 1990; 1992; RUIZ-PINO *et al.*, 1991). Such environmental changes of inputs may be compared with some socio-economic data of the known evolution of the Mediterranean countries (increases in inhabitants, in mean gross national product, in energy consumption, as compiled by UNEP, 1988). Moreover, the six-box model allowed to simulate the surface water change of lead concentration from 1983 to 1993. The simulation of atmospheric input of lead was provided by lead consumption in gazoline, the biological transfer was summarized by new production and trace metal concentration in phytoplankton, the residence time of lead in the surface layer (0 -100m depth) was about 1 year, and the sedimentation buried about 50% of the incoming lead (NICOLAS *et al.*, 1994).

From phosphate and nitrate budgets at basin scale, three questions are arising, concerning processes at biological cell or molecular scales. The first one concerns the phosphate input, as riverine input of phosphate only represents about 25% of the estimated terrestrial inputs. Consequently, the major input of useful phosphorus is the particulate fraction which is dissolved as emphasized by FROELICH (1988) in the estuaries or in the plume rivers. But redissolution processes are badly known at the land-river-sea interfaces. The second question concerns the nitrate budget, the main input of nitrate probably comes from the biological uptake of atmospheric nitrogen, a non quantified process from quite unknown bacterioplankton species (BETHOUX *et al.*, 1992). The third question is the use of the specific signature of N/P molar ratio of about 22 in the Mediterranean, instead of about 16 (the so-called "REDFIELD ratio") in the great oceans, which may be a constraint for the Mediterranean ecosystem. New technics such as organic pigments and flow cytometry may give a new picture of the ecosystem and new constraints for the modelling of biogeochemical cycles.

Concerning trace metals, progress in clear sampling and analytical method allows to propose budgets of dissolved and particulate matters. In spite of the first attempt to describe biological transfers of trace metals through new production (i.e. BETHOUX *et al.*, 1990), respective implications for this transfer and for biological activity depend of the chemical speciation of bioactive trace-metals. All these questions are arising from box-model studies at a basin scale, but box-models cannot give solution for problems acting at small scales of time and space.

REFERENCES

BETHOUX J.-P., 1980. Mean water fluxes across sections in the Mediterranean Sea, evaluated on the basis of water and salt budgets and of observed salinities. *Oceanol. Acta* , 3 : 79-88 .

BETHOUX J.-P., 1989. Oxygen consumption, new production, vertical advection and environmental evolution in the Mediterranean Sea. *Deep Sea Res.*, 36 : 769-781.

BETHOUX, J.-P., COURAU, P., NICOLAS, E. and RUIZ-PINO, D., 1990a. Trace metal pollution in the Mediterranean Sea. *Oceanol. Acta*, 13 : 481-488.

BETHOUX J.-P., MORIN P., MADEC C. and GENTILI B., 1992. Phosphorus and nitrogen behaviour in the Mediterranean Sea. *Deep-Sea Res.*, 39 : 1641-1654.

FROELICH P.N., 1988. Kinetic control of dissolved phosphate in natural rivers and estuaries; a primer on the phosphate buffer mechanism. *Limnol. Oceanogr.*, 33 : 649-668.

MOREL A. and ANDRE J.-M., 1991. Pigment distribution and primary production in the Western Mediterranean as derived and modelled from space (CZCS) observations. *J. Geophys. Res.*, 96 : 12685-12698.

NICOLAS E., RUIZ-PINO D.P., BUAT-MENARD P. and BETHOUX J.-P., 1994. Abrupt decrease of lead concentration in the Mediterranean Sea : a response to antipollution policy. *Geophys. Res. Letters*, 21, 19 : 2119-2122.

RUIZ-PINO D., JEANDEL C., BETHOUX J.-P. and MINSTER J.-F., 1990. Are the trace metal cycles balanced in the Mediterranean Sea? *Palaeo. Palaeoecology*, 82 : 369-388.

RUIZ-PINO D., NICOLAS E., BETHOUX J.-P. and LAMBERT C., 1991. Zinc budget in the Mediterranean Sea: a hypothesis for non-steady stae behaviour. *Mar.Chem.*, 33 : 145-169.

UNEP. 1988. Le plan bleu, résumé et orientations pour l'action, Rac/Blue Plan, 94pp.

SEASONAL VARIABILITY OF THE NITROGEN CYCLE IN THE MEDITERRANEAN SEA

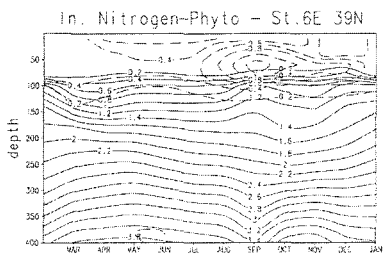
A. CRISE, G. CRISPI, E. MAURI and R. MOSETTI

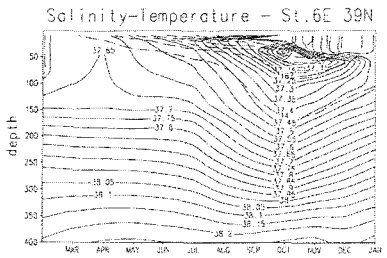
Osservatorio Geofisico Sperimentale, P.O. Box 2011, 34016 Trieste, Italy

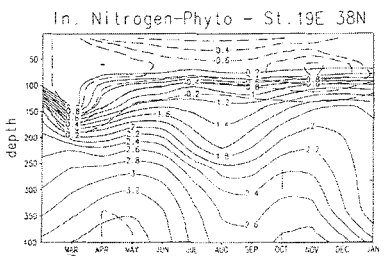
The role of upper ocean biochemical processes in determinig the basic trophic kinetics and distribution is deeply connected with the dynamical processes that determine the physical forcings active at the biological scales. The seasonal signal of the lower trophic level evolution in the Mediterranean Sea is reproduced by means of a trophodynamic model representing the aggregated nitrogen cycle in oligotrophic conditions. The total nitrogen, divided in inorganic nitrogen, phytoplankton and detritus, maintains the numerical conservativeness of the scheme described in CRISE *et al.* (1992), but includes exchanges at the Gibraltar Strait, because of the nitrogen and phytoplankton relaxation to climatological profiles in the transition zone between the Alboran Sea and the Atlantic Ocean all along the simulation.

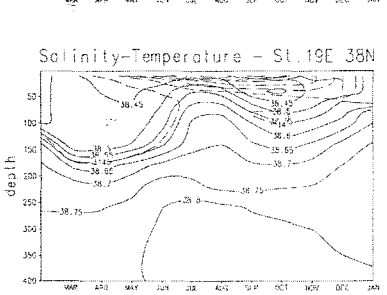
Limiting factors of the phytoplankton growth are the sea temperature, the irradiance and the available nutrient. The limiting factors are all considered to be depth dependent, and are respectively represented by the STEELE (1962), the EPPLEY (1972) and Michaelis-Menten uptake formulations. The hydrodinamical horizontal processes that affect the biogeochemical state variables are explicitely taken into account, as well as the vertical dynamics governed by advection- diffusion processes and the convective adjustments. For this purpose, the ecomodel is tightly coupled with the hydrodynamics simulation as developed in the frame of MERMAIDS project by PINARDI *et al.* (1993). This MOM based general circulation model has a 1/4 degree horizontal grid size and 31 vertical levels. The dynamical forcing terms used are the NMC winds, the COADS monthly mean clouds maps and the heat fluxes as in CASTELLARI *et al.* (1993). Even with a highly aggregated ecomodel, the seasonal cycle exibits a marked variability induced principally by the horizontal advective forcing. To study this effect on the ecomodel, the basic experiment considers the light as constant all over the basin varying only in time on an astronomical base. Two significant examples are shown to confirm the above statements. The differences in tracer concentration are all due to the internal dynamics, because the inorganic nitrogen and phytoplankton are initialized with the same climatological profiles in the whole Mediterranean. The hydrodynamical model is spinned up for eight years and the presented results were obtained in the second year of the ecological model run.

The inorganic nitrogen (full) and the phytoplankton (dashed) concentrations, all in micromoles Nitrogen per liter, are presented in two typical stations, the first in the Catalan-Algerian Basin and the second in the Ionian Sea. Salinity (full) and temperature (dashed) are also provi-ded in the same stations. In the Catalan-Algerian Basin station the seasonal variability slightly affects the inorganic nitrogen distibution below the euphotic zone, showing instead a stronger seasonal signal in the first hundred meters. After an initial period of mixing mainly due to convective adjustment, temperature and salinity exhibit the typical late spring-summer stratification, preventing the exchange of upper layer. The phytoplankon response to the higher irradiance and relatively abundant nitrates decreases in April showing a well shaped subsurface maximum in late summer. This second maximum is enhanced by the low salinity Modified Atlantic Water. In the Ionian Sea station the wind stirring creates an homogeneous phytoplankton maximum all along the water column even below the euphotic zone. The stratification is evident during the summer and early autumn and creates an isopycnal barrier with the surface layer. The anticyclonic regime of the northern Ionian is stronger in summer affecting progressively the inorganic nitrogen concentration below 150 meters. This effect is masked in the physical tracers and the intrusion of less salty water does not seem to influence the trophic dynamics. In winter, the progressive mixing of the upper layer creates again the homogeneous conditions typical of the beginnnig of the cycle.









REFERENCES

CRISE A., CRISPI G. and MOSETTI R., 1992. Paralleliza-ion of a coupled hydrodynamical ecomodel, CNR/PFI, Technical report N. 1/135.

STEELE J.H., 1962, Environmental control of photosynthesis in the sea, *Limnol. Oceanogr.*, 7, 137-150.

EPPLEY R.W., 1972, Temperature and phytoplankton growth in the sea, *Fish. Bull.*, 70, 1063-1085.

PINARDI N., ROETHER W., MARSHALL J., LASKARATOS A., KRESTENITIS Y. and HAINES K., 1993, Mediterranean Eddy Resolving Modelling And InterDisciplinary Studies. Contract MAST 0039-C(A) Final Scientific and Management Report.

CASTELLARI S., PINARDI N. and LEAMAN K., 1993, A heat budget study for the Mediterranean Sea, submitted.

A

BIOMINERALIZATION AND DISSOLVED ORGANIC MATTER IN THE SEA : IMPLICATIONS FOR MARINE BIOEGEOCHEMICAL MODELS

Venugopalan ITTEKKOT

Institute of Biogeochemistry and Marine Chemistry, University of Hamburg
Bundesstrasse 55, 20146 Hamburg, Germany

There are still large uncertainties in the size and turnover times of dissolved organic matter (DOM) in the sea, which represents one of the largest pools of organic carbon on the earth (DEGENS & ITTEKKOT, 1983). The uncertainties in the size of the DOM-pool are mostly related to problems associated with the methods involved in its determination. Two of the most widely employed techniques are wet oxydation and high temperature combustion (HTC) techniques. Concentration of dissolved organic carbon (DOC) measured with HTC techniques are higher than those measured by the wet oxydation techniques. More recently, the introduction of high temperature catalytic oxydation (HTCO) appeared to confirm the higher concentrations, although subsequent work has failed to provide any conclusive evidence for such high concentrations (KIRCHMAN *et al.*, 1993). Interesting, however, was the possibility that the marine DOM had a large component which had high molecular weight and which was chemically stable, but biologically labile.

Because of the size of the DOM and of the possible variabiliy in the production and turnover times of its various fractions (BILLEN *et al.*, 1980; ITTEKOT, 1982), a better understanding of the processes controlling its nature, production and fate is a prerequiste for modelling the role of the DOM in marine carbon cycle.

The DOM-problem is examined here from the geochemist's viewpoint. Attention will be focussed on the role of biominerals in the formation of marine DOM. Biominerals consist of an organic and an inorganic phase whose nature and interaction with each other determine the type of biomineral formed (DEGENS, 1976). Biogenic opal is an example of such a biomineral forming the frustules of diatoms, which are the major group of CO_2-fixing organisms in the sea. The aim of the presentation is to show the importance of diatom mediated biogeochemistry of silicon in the sea as the major controlling factor in the production and recycling of marine DOM and, consequently, in the marine carbon cycle.

REFERENCES

BILLEN G. *et al.*, 1980. Concentration and microbial utilization of small organic molecules in the Scheldt Estuary, the Belgian Coastal Zone of the North Sea and The English Channel. *Est. Coast. Mar. Sci.*, 11 : 279-294.

DEGENS E. T. & V. ITTEKKOT, 1983. Dissolved organic carbon - an overview. Mitt. geol. Paléontol. Inst. Univ. Hamburg, 55 : 21-38.

DEGENS E. T., 1976. Molecular mechanisms on carbonate, phosphate and silica deposition in the living cell. *Topics in Current Chemistry*, 64 :1-112.,

ITTEKKOT V., 1981. Variations of dissolved organic matter during a plankton bloom: qualitative aspects based on sugar and amino acid analyses. *Mar. Chem.*, 11 : 143-158.

KIRCHMAN D. L. *et al.*, 1993. Dissolved organic matter in biogeochemical models in the ocean, *In* : Towards a Model of Ocean Biogeochemical Cycles, (Eds) G. T. EVANS & M. J. R. FASHAM, NATO-ARI Series, Springer-Verlag, Berlin, pp 209-225.

MODELLING DYNAMICS OF PHYTOPLANKTON IN THE MEDITERRANEAN

T. LEGOVIC and A. CRUZADO

Centre d'Estudis Avancats de Blanes, 17300 Blanes, Spain

Phosphorus, nitrogen and silica have been recognized as elements most often participating in nutrient limitation of phytoplankton growth in the Mediterranean. According to in situ enrichment studies, phosphorus tends to limit phytoplankton growth more intensively than nitrogen (JACQUES *et al.*, 1973; FIALA *et al.*, 1976; POJED and KVEDER, 1977). OWENS *et al.* (1989) concluded that in the western part N limitation is more probable than P limitation. Finally, there are parts of the Mediterranean where silica has been demonstrated to limit phytoplankton growth more often and more intensively than either phosphorus or nitrogen (MORKOC *et al.*, 1994).

Models of processes that describe phytoplankton growth limited by a single nutrient have been perfected over 20 years and a lot is known about their ability to reproduce phytoplankton dynamics. Here we report on development of models that combine the above three nutrients to describe and predict phytoplankton growth in the Mediterranean Sea. Specifically we are trying to answer the following questions: What is the extent of each nutrient in limiting phytoplankton growth? What other processes we need to consider at the minimum to correctly describe observed recurrent phytoplankton peaks? Finally, how much are the bacteria and zooplankton affecting phytoplankton dynamics?

REFERENCES

JACQUES G., CAHET G., FIALA M., PANOUSE M., 1973. Enrichissement de communautés phytoplanctoniques néritiques de Méditerranée nord-occidentale. *J. Exp. Mar. Biol. Ecol.*, 11 : 287-295.

FIALA M., CAHET G., JACQUES G., NEVEUX J., PANOUSE M., 1976. Fertilisation de communautés phytoplanctoniques. I. Cas d'un milieu oligotrophique : Méditerranée nord-occidentale. *J. Exp. Mar. Biol. Ecol.*, 24 : 151-163.

POJED I. and KVEDER S., 1977. Investigation of nutrient limitation of phytoplankton production in the northern Adriatic by enrichment experiments. *Thalassia Yugosl.*, 13 : 177-196.

OWENS N.J.P., REES A.P., WOODWARD E.M.S., MANTOURA R.F.C. Size-fractioned primary production and nitrogen assimilation in the north-nortwest Mediterranean Sea during January 1989. *In* : First Workshop on the Northw. Med. Sea, CEC Water. Poll. Res. Rep., Paris, pp. 1216-34.

MORKOC E., TUGRUL S., OKAY O.S. and LEGOVIC T, 1994. Eutrophication and hydrochemical characteristics of the Izmit Bay. *In* : Proc. of Int. Spec. Conf. on Mar. Disp. Sys., Istambul, pp. 335-344.

MODELLING THE EFFECT OF FOOD WEB ON BIOGEOCHEMICAL PROCESSES

Paul NIVAL

Station Zoologique, Laboratoire d'Ecologie du plancton marin
BP 28, 06230 Villefranche-sur-mer, France

Model structure. Modelling is still at the beginning. Its progress depends strongly on the state of description of the system, the dynamics of which is intended to simulate. The food chain concept is an important element of the biogeochemical models. Different trophic levels are usually considered. However, the knowledge of small organisms has progressed rapidly during the recent years. This part of the trophic web was ignored ten years ago mainly because neither the sampling and observations means were developped, nor the concepts elaborated. The food web structure has to be introduced in models.

The microbial food web which parallels the macrobial food web and allows the complete recycling of nutrients is necessary to explain most of the properties of regeneration of nutrients. Although model structure has to stay simple it should embed the major biological and chemical properties known from experimental studies. Interactions between biological, chemical and physical processes are important but the space and time where interaction develops is very often not at the scale selected for the design of the model.

At the other end of the food web the gelatinous organisms or large crustaceans are well described but their role is not well understood. These large organisms are scarse compared to bacteria so that their effect is not easily measured. They are important for the dynamics of many chemical elements either by their fecal pellet production or by their strong vertical migration. During some short period of time these large gelatinous organisms are relatively abundants (appendicularians, salps). The determinism of these blooms is not well understood but the strong effect of their feeding on particulate matter lay the task of developping the proper processes interactions on the modellers.

Different models have been developped to deal with food web which can be the base of simulations of segments of the geochemical cycle of some elements.

Processes to incorporate into models. A model should have a vertical dimension to accommodate the vertical passive transport by sinking or active transport by migration. Fronts which are the most productive in the Mediterranean sea are also the place where organic particulate matter is injected continuously in deep water. Hydrodynamic processes are forcing strongly biological processes in such areas. The second thing to improve in models is a set of biological functions which can represent the conditions of assimilation, storage, transfer of a chemical element in the food web. Factors regulating the ratio between the amout of a chemical element and biomass for different biological variables, as well as the function structure should be defined. Another important improvement will be in the speciation of chemical elements in the water and under the effect of the substances produced by living organisms.

The third important field of development is the scaling effect. In nature the small scale processes have an average effect on the mesoscale. Non-linearities are characteristics of biological processes and express couplings which underlay the processes effects.

Biomass of an element of the food web is usually considered as a single variable. It should have a more complex dynamics because cell cycle is important for unicellular organisms (it has been demonstrated for picoplankton) and cohort dynamic is basic for zooplankton. It is now clear that most of the food web structure and of the interactions have to be carefully reconsidered for each case study. The sub grid parametrization is an important step in the process of model design.

Scales, data acquisition. A model cannot be designed without any time and space domain which is characteristic of the phenomenon considered. Data are necessary to define this domain and also to calibrate and validate the model. Modelling is one of the method essential to understand a phenomenon. Observation and experimentation are two others. They have to interact and continuously exchange information and results.

Exernal forcings. The major problem in coupling physical processes with biological or chemical ones is that the scale of interaction is not well known at present. Vertical mixing, for instance, which can be of different types, keeps the biological system in a permanent initial state if it is strong enough and, in any condition, damps out nearly most of the dynamics of the biological system (limit cycle, multiple equilibrium points). However the effect of external variables, wind, calorific energy, river input, is usually assumed constant or slowly variable, although it is mostly short and intense.

It appears that, on one hand, the long term internal behaviour of a system is not well defined and on the other hand long term forcings are not very well evaluated, mainly because they are multidimensional.

In order to improve the biogeochemical models, it is necessary to continue on these lines and develop observations at sea and experimental work in parallel to models :

- on short term response because interactions are mostly at the small scale and we have the capacity to measure continuously or to experiment in mesocosms at these time scales;
- on long term behaviour because most of the interactions of climate and ecosystems are presumably developping also at this time scale.

INTERDISCIPLINARY MODELLING - PHYSICAL PROCESSES

Dong-Ping WANG

Marine Sciences Research Center, State University of New York, Stony Brook
NY 11794, USA

Physical processes consist of mixing and advection. The mixing processes can be divided into boundary and interior mixing. The boundary mixing, whether it is on the ocean surface or at the ocean bottom, is relatively well studied. Surface mixed-layer models are routinely used in study of upper-ocean thermal structures, and bottom mixed-layer models are often used in study of tidal mixing in shallow seas. In contrast, the interior mixing remains little understood. Modeling of interior mixing is usually based on simple *ad hoc* assumptions.

Applications of the one-dimensional mixed-layer models to the interdisciplinary modelling are quite common. The upper-ocean temperature and entrainment rate, predicted from surface mixed-layer models, can be used to calculate respectively the biological and chemical reaction rates and upward nutrient flux. Knowledge of the turbulence structure in the mixed layer can be used to calculate the trajectories of planktonic particles. Potential feedback from biology to physical process, such as the attenuation of optical depth by phytoplankton bloom, also has been explored.

While mixed-layer models are realistic, the general ocean circulation (three-dimensional advective processes) models are still quite primitive. The computer power is only marginal and the data base is lacking. Very few regional circulation models had ever been verified. So far, in interdisciplinary regional models, the flow fields usually are derived from simple idealizations. The common approaches use estimations from a well-known circulation pattern (such as the coastal upwelling circulation) or from the geopotential surfaces. The idealized flow patterns nevertheless are useful in providing mean flow trajectories for calculation of, for example, the dissolved and particulate material budget, the sedimentation pattern, and the larvae recruitment.

Embedded in the large-scale regional circulation are the mesoscale activities. These motions are marked by strong flow convergence and divergence. A well-known example is the frontal eddy and filament along a meandering current. The flow convergence and divergence can have major impacts on the biology. Local divergence (upwelling) will bring up nutrients, but, it also may cause larger advective loss. Local convergence will concentrate floating particles (food), but, it also may bring planktons below the photic zone. The complex interaction between frontal circulation and biological system can result in wide varieties of biological and chemical response.

We feel that a major opportunity in the interdisciplinary modeling is the study of biological and chemical system in mesoscale fronts. It is now feasible to describe the general convergence and divergence pattern in a frontal meander. Coupling such advective pattern to a biological model can be a useful tool to examine the observed biological heterogeneity. The model also can be used to explore the larger question of contributions of frontal system to the overall biological budget. Moreover, since the biology is sensitive to flow divergence, the advective processes themselves may also be quantified.

BIOGEOCHEMICAL MODEL OF TRACE ELEMENTS IN THE WESTERN MEDITERRANEAN SEA

R. WOLLAST

Université de Bruxelles, laboratoire d'Océanographie Chimique, Campus Plaine 208, bd. du Triomphe, 1050 Bruxelles, Belgique

A

The vertical distribution of trace elements in marine systems results from the interaction of physical, chemical and biological processes. The distribution of trace elements in the water column and their fluxes at boundaries were intensively studied during the European River Ocean System (EROS 2000) project. These measurement allowed to establish a coherent mass balance for trace elements in the system and to develop a biogeochemical model describing their behaviour.

Many trace metals behave like nutrients and are incorporated actively or passively in the living material in the euphotic zone and released in deep waters by bacterial degradation of the organic matter. These processes play an important role in the scavenging of the trace elements and their removal from the water column.

It is possible to describe their behaviour by using a box model which takes into account the fluxes of the element at the boundaries, the water circulation , chemical processes and the biological activity. The structure of the model is shown schematically in figure 1. This model allows to predict long term changes of the composition of the system due to the perturbations, for instance of anthropogenic origin. It is also possible to evaluate what was the situation before presently existing human perturbations.

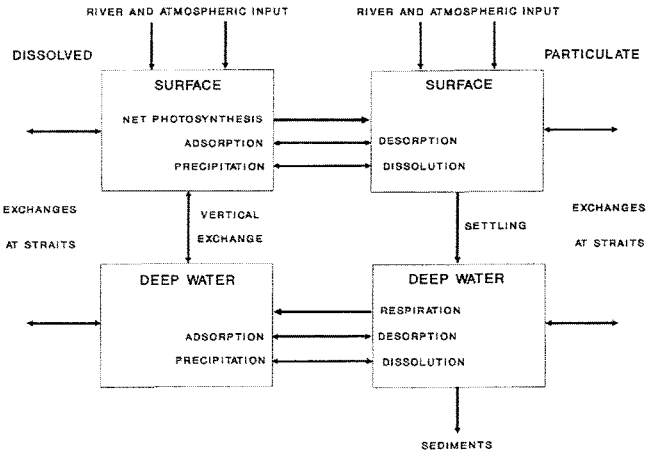


Figure 1. Schematic representation of the biogeochemical model describing the behaviour of trace elements in the Western Mediterranean Sea.

B

COMITÉ BENTHOS

Président : Gaston FREDJ
Vice-Présidents : Charles-François BOUDOURESQUE, Maurizio PANSINI

POLYCHAETE, BACTERIA AND MICROPHYTOBENTHOS FLUCTUATIONS IN SUBTIDAL SEDIMENTS OF THE LIGURIAN SEA (NORTH WESTERN MEDITERRANEAN)

ALBERTELLI G.[1], DANOVARO R.[2], DELLA CROCE N.[2], FABIANO M.[3]
FRASCHETTI S.[2]

[1] Dipart. di Scienze dell'Ambiente e del Territorio, Univ. di Milano, Italy
[2] Istituto Scienze Ambientali Marine, Univ. di Genova,16038 S. Margherita L., Italy
[3] Dipart. di Biologia Animale ed Ecologia, Univ. di Cagliari, Italy

Benthic bacteria and microphytobenthos represent important food source for macrofauna (NEWELL and FIELD, 1983) but their quantitative role in the diet of polychaetes has not been yet assessed (CAMMEN, 1980; MONTAGNA, 1984). The present study was designed to test the presence of a relationship between the fluctuations of the polichaete community and the fluctuations of the abundance and biomass of bacteria and microphytobenthos, representing a possible food source. From January 1991 to February 1993, a sandy bottom community at 10 m depth (Ligurian Sea) was investigated monthly by SCUBA divers. The following parameters were considered in the sediment : polychaete abundance (collected by using a suction device system, mesh sieve used 1 mm size), benthic bacterial density and biomass (estimated by epifluorescence microscopy), micro-phytobenthos biomass (measured as chlorophyll a) organic carbon (OC) and nitrogen (ON) (measured using a CHN analyser). Organic carbon showed the highest values both in winter (3.88 ± 1.89, 2.29 ± 0.57, and 2.02 ± 0.06 mg g^{-1} sediment d.w. in February and December 1991, January 1993) and spring (2.21 ± 0.14, 3.14 ± 1.11 mg g^{-1} sediment d.w. in April 1991 and May 1992, respectively), while the lowest at the beginning of summer (0.85 ± 0.00 mg g^{-1} sediment d.w. in June 1992). Nitrogen showed the highest value in October 1992 (0.46 ± 0.06 mg g^{-1} sediment d.w.) and the lowest in winter (0.14 ± 0.02, 0.19 ± 0.00 mg g^{-1} sediment d.w. in December 1991 and February 1993 respectively). Also chl-a showed wide seasonal fluctuations with minimum values in winter (0.18 ± 0.02 mg g^{-1} sediment d.w. in December 1992 and January 1993, respectively) and maximum in summer (3.96 ± 0.89 mg g^{-1} sediment d.w. in July 1991). Bacterial density and biomass varied seasonally being characterized during both years by spring (density: 2.68 x 108 g^{-1} of sediment d.w. in April 1991, 5.07 x 108 g^{-1} of sediment d.w. in April 1992; biomass: 11.94 and 21.06 mgC g^{-1} of sediment d.w., in April 1991 and 1992) and autumn peaks (density: 26.7 x 108 g^{-1} sed.d.w. in October 1991, 5.8 x 108 g^{-1} sed.d.w. in December 1992; biomass: 88.0 and 20.37 mgC g^{-1} sediment d.w., in October 1991 and December 1992, respectively). Polychaetes showed high seasonal fluctuations with spring peaks, and were significantly correlated with the chl-a trend (Spearman Rank Correlation, r = 0.94, p = 0.016, Fig. 1). On the contrary, no correlation was found with other sediment parameters. Deposit feeders were the most important group (52 %). They were significantly related to bacterial abundance (Spearman Rank Correlation, r = 0.985 p = 0.0004, Fig. 2).

It is well known that the standing stock of organic carbon does not always represent a measure of the amount of food readily available for benthic organisms. Food supply may have a major role in determining seasonal fluctuations of macrobenthos. Winter OC peaks, coupled with high C:N ratios (up to 17 in February 1991), suggest that the composition of the organic matter is mainly of refractory material (allochthonous origin). For this reason, the lack of significant correlations between polychaetes and organic carbon is not surprising. On the contrary, the significant correlation between the whole polychaetes community and microphytobenthos and between deposit feeders and bacteria, is consistent with those previously reported by MONTAGNA (1984), and it suggests the importance of these two components in the diet of polychaetes even though the presence of significant correlation between polychaetes and microbial parameters does not guarantee a cause-effect relationship and must be considered with caution. Nonetheless, since bacteria and microphytobenthos account for the majority of the labile organic matter and considering the oligotrophy of the Ligurian Sea, it is not unreasonable to assume that they may have a major role in structuring the polychaete community, especially as far as seasonal changes in trophic structure are concerned.

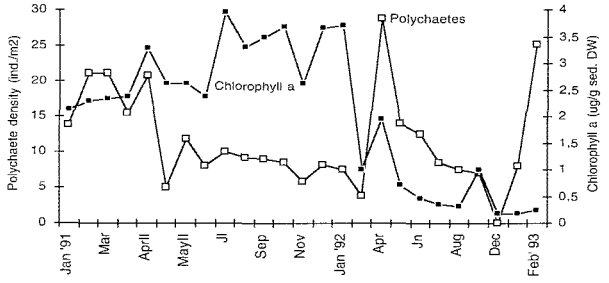


Fig. 1 Seasonal changes of polychetes abundance and chl-a content in the study area.

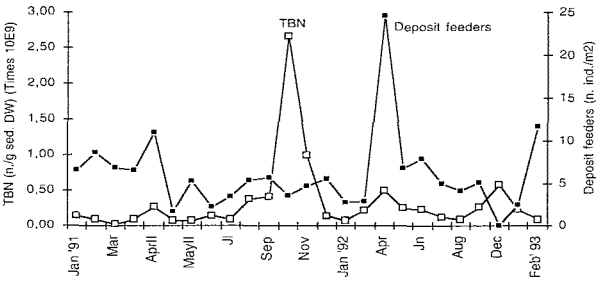


Fig. 2 Seasonal changes of deposit-feeders polychaete density and total bacterial number (TBN).

REFERENCES

CAMMEN L.M. 1980. - The significance of microbial carbon in the nutrition of the deposit-feeding polychaete *Nereis succinea*. *Mar. Biol.*, 61: 9-20.

MONTAGNA P.A., 1984. - In situ measurements of meiobenthic grazing rates on sediment bacteria and edaphic diatoms. *Mar. Ecol. Prog. Ser.*, 18 : 119-130.

NEWELL R.C. and FIELD J.C., 1983. - The contribution of bacteria and detritus to carbon and nitrogen flow in a benthic community. *Mar. Biol. Letters*, 4 : 23-36.

AGE AND GROWTH OF *CHAMELEA GALLINA* (BIVALVIA : VENERIDAE) IN THE CENTRAL ADRIATIC SEA OBTAINED BY THIN SECTIONS

Enrico ARNERI, Gianfranco GIANNETTI, Raffaela POLENTA & Bruno ANTOLINI

Istituto di Ricerche sulla Pesca Marittima (IRPEM), C.N.R., Ancona, Italy

Chamelea gallina is a very common bivalve in Mediterranean inshore waters where it inhabits well sorted fine sand biocoenosis (PICARD, 1965) : along the Western Adriatic shore it is found in shallow sandy bottoms down to a depth of about 13 metres and it sustains an important fishery worth an estimated total catch of about 100000 tons per year in the 80's (FROGLIA, 1989).

Fishery for *Chamelea gallina* along the Western Adriatic coast is performed by means of hydraulic dredges : in order to assess the available biomass of *Chamelea gallina* experimental surveys are carried out every year by IRPEM in an area covering about 200 km of coastline around Ancona. Material for this study was collected in June 1991, October 1991, November 1991, February 1992, June 1992 and December 1992. 917 specimens ranging from 7 to 49 mm in shell length were retained for the growth study.

Shell sectioning as method for investigating growth rates in bivalves is a long term established technique (RHOADS and LUTZ, 1980), it has been applied recently to the stock of *Chamelea gallina* of the Western Mediterranean (RAMON and RICHARDSON, 1992).

The right valve was sectioned from the umbo to the ventral margin along the axis of maximum growth in order to obtain a thin section of about 20-30μ mounted on a glass slide. The section was ground, polished and examined using a dissecting microscope under reflected light : 719 sections could be interpreted showing distinct annual increments. Annual periodicity was validated observing the period of formation of the increment on the ventral margin of the shell : slow growth increments are formed once per year approximately between October and February. The analysis of length frequency distributions of the experimental samples is in agreement with these findings .

A complete record of size at age for each *Chamelea gallina* was obtained by measuring incremental growth as the distance from the ventral margin of each translucent band to the umbo using an Image Analysis System linked to a dissecting microscope.

Chamelea gallina spawns in Central Adriatic mainly in late spring (POGGIANI *et al.*, 1973) therefore conventional birthday was assumed to be the 1st of July. The maximum age found in the sample is 8 years.

Parameters of the von Bertalanffy growth function together with their asymptotic standard errors were computed by means of non-linear regression analysis using the program FISHPARM (SAILA *et al.*, 1988):

L_∞= 41.6 (0.54) K= 0.48 (0.016) t_0= - 0.01 (0.17)

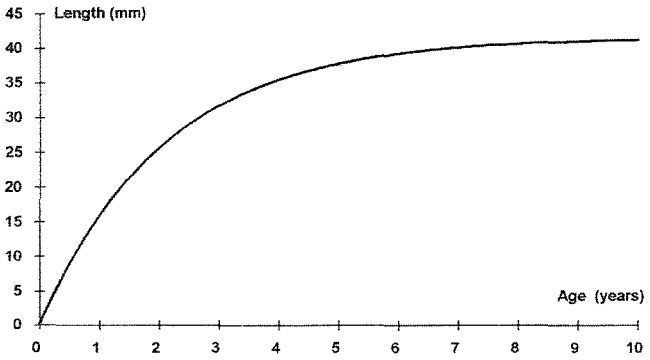


Fig. 1 - Von Bertalanffy growth curve of *Chamelea gallina*.

REFERENCES

FROGLIA, C., 1989. Clam fisheries with hydraulic dredges in the Adriatic Sea. *In* : J.F. Caddy (Ed.) - Marine Invertebrate Fisheries : 507-524

PICARD, J., 1965. Recherche qualitative sur les biocoenoses marines des substrats meubles dragables de la région marseillaise. *Rec. Trav. Sta. mar. Endoume* 52 : 1-160.

POGGIANI, L., PICCINETTI, C. and PICCINETTI MANFRIN G., 1973. Osservazioni sulla biologia dei molluschi bivalvi *Venus gallina L.* e *Tapes aureus* Gmelin nell'Alto Adriatico. Note Lab. Biol. Mar. Pesca, Fano, 4 (8) : 191-209.

RAMON, M. and RICHARDSON, C.A., 1992. Age determination and shell growth of *Chamelea gallina* (Bivalvia: Veneridae) in the Western Mediterranean. *Mar. Ecol. Progr. Ser.*, 89 (1) : 15-23.

RHOADS, D.C. and LUTZ, R.A. (Eds), 1980. Skeletal growth of aquatic organisms. Biological records of environmental change. Topics in Geobiology, 1 : 750 pp.

SAILA, S., RECKSIEK, C. and PRAGER, M., 1988. Basic Fishery Science Programs. Elsevier Amsterdam : 230 pp.

B

L'ÉPIPHYTISME : UN MODE DE VIE DES ALGUES MACROPHYTES DES CÔTES ROUMAINES DE LA MER NOIRE

Adrian BAVARU

Université Ovidius, Constantsa, Roumanie

On sait que l'épiphytisme est un phénomène très répandu dans le monde des algues marines, et on estime que 50% des algues peuvent vivre comme épiphyte, contre 10% pour les végétaux verts supérieurs. Le phénomène est réparti également entre le macrobenthos et le microbenthos. Les avantages de l'épiphytisme sont (1) une augmentation de la quantité de lumière reçue par rapport au substrat benthique, et (2) une protection contre l'hydrodynamisme dans la zone côtière, en particulier par déplacement du gravier-support vers la profondeur (par les courants) quand l'eau superficielle est surchauffée (en été) ou gèle (en hiver).

Le littoral roumain présente des caractéristiques négatives pour le développement des algues marines : (1) une forte turbidité des eaux littorales (et donc une faible pénétration de la lumière); (2) une forte agitation de l'eau (le trait de côte est en effet linéaire, sans baies ni sites abrités); (3) des températures de l'eau et de l'air qui présentent des maximums très élevés (en été) et des minimums très bas (en hiver).

Les algues épiphytes des côtes roumaines peuvent généralement se fixer de façon non sélective sur des hôtes très variés. Un nombre restreint d'entre-elles "préfèrent" toutefois un hôte particulier. C'est le cas de *Sphacelaria cirrhosa* (Roth) C. Agardh qui se développe uniquement sur *Cystoseira barbata* (Goodenough et Woodward) C. Agardh et d'*Acrochaetium savianum* (Meneghini) Nägeli qui n'a été rencontré que sur *Dasya baillouviana* (Gmelin) Montagne.

Le long des côtes roumaines, les seules algues pérennes de grandes dimensions (plus d'un mètre de longueur) portant des épiphytes sont deux espèces du genre Cystoseira : *C. barbata* et *C. crinita* (Desfontaines) Bory *f. bosphorica* (Sauvageau) Zinova et Kalugina. La première porte une flore épiphyte plus riche que la seconde. Cette constatation est très intéressante, parce que les deux espèces se distinguent ainsi non seulement par des particularités morphologiques, mais aussi par la composition de leur épiflore et de leur épifaune.

Chez *Cystoseira barbata*, le taux maximum d'épiphytisme se trouve chez les individus qui vivent entre 1 et 3 m de profondeur, en particulier dans les zones calmes (Tuzla, Varna-Veche), où les *Cystoseira* atteignent leur développement maximal.

Les espèces les plus sciaphiles se développent seulement sur le disque basal ou sur la partie basale du stipe : *Titanoderma cystoseirae* (Hauck) Woelkerling *et al.* et *Peyssonnelia dubyi* Crouan et Crouan par exemple. Les espèces photophiles, en revanche, se développent seulement sur les branches : *Laurencia paniculata* (C. Agardh) J. Agardh, *Corynophlaea umbellata* (C. Agardh) Kützing et *Feldmannia irregularis* (Kützing) Hamel; on peut y ajouter des espèces appartenant en particulier aux genres *Ceramium, Polysiphonia, Porphyra, Cladophora* et *Enteromorpha*.

Le développement des épiphytes présente deux pics saisonniers : le premier à la fin du printemps et le deuxième au début de l'automne. La biomasse des épiphytes y atteint des valeurs impressionnantes, bien que plus faibles qu'il y a deux ou trois décennies.

Dans un travail ultérieur, nous préciserons la dynamique saisonnière des épiphytes le long du littoral roumain de la mer Noire, ainsi que le mode de fixation de ces épiphytes sur leur hôte.

REFERENCES

BAVARU A., 1972. Evaluari cantitative in populatiile de *Cystoseira* la tarmul romanese al Maril Negre. *St. si Cercet., Ser. Bot.*, Roumanie, 24 (2) : 95-101.

BAVARU A. et SKOLKA H., 1988. L'influence du gel et de la glace sur la végétation algale du littoral roumain de la mer Noire. *Rapp. Com. int. Mer Médit.*, 31 (2-3) : T4.

BAVARU A. et VASILIU F., 1985. La situation actuelle de la végétation macrophyte du littoral roumain de la mer Noire. *Rapp. Com. int. Mer Médit.*, 29 : 205-206.

BAVARU A., BOLOGA A. et SKOLKA H., 1991. Revision of benthic marine algae along the Romanian shore of the Black Sea. *Internation. J. mar. Biol. Oceanogr. Oebalia*, Ital., 17 (2) : 535-551.

BIOGÉOGRAPHIE ET ORIGINE DE LA FAUNE DES AMPHIPODES DE MÉDITERRANÉE

D. BELLAN-SANTINI[1] et S. RUFFO[2]

[1] Centre d'océanologie de Marseille, URA 41, Station marine d'Endoume, rue Batterie des Lions, 13007 Marseille, France

[2] Museo Civico di Storia naturale, Lungadige Porta Vittoria, 37129 Verona, Italia

Au terme d'une révision et d'un recensement que l'on peut qualifier d'exhaustif, la faune des amphipodes de Méditerranée (famille des Cyamidae et sous ordre des Hyperiidea exclus) compte 453 espèces ce qui représente un peu moins de 10% de la faune mondiale. On peut considérer que c'est une des mieux connues au monde. Les connaissances ne sont pas égales pour l'ensemble de la Méditerranée, 97 % des espèces sont connues du bassin occidental alors que seulement 54% le sont pour le bassin oriental et 52% pour l'Adriatique. Il est probable que, comme ce fut déjà observé pour d'autres groupes systématiques, cette différence corresponde en partie à une effective pauvreté de la diversité spécifique, mais certainement, surtout pour la Méditerranée orientale, ceci est dû aussi à un effort de recherche moindre.

L'Adriatique abrite un petit nombre d'espèces considérées actuellement comme limitées à cette mer : *Ampithoe spuria, Bogidiella dalmatina, Apherusa ruffoi, Neogammarus adriaticus, Lepidepecreum subclypeatum, Prachynella mediterranea, Degocheirocratus spani*, cette dernière espèce appartient de plus à un genre endémique.

Le nombre des espèces connues seulement de Méditerranée orientale est relativement réduit : *Lysianassa caesarea, Valettietta punctata, Psammogammarus gracilis, Phippsiella pseudophippsia, Orchestia kosswigi, Lunulogammarus turcicus, Melita virgula, Ericthonius argenteus* en plus de *Cheirophotis mediterraneus* qui appartient à un genre exclusivement indo-pacifique, et à trois espèces indo-pacifiques (*Bemlos leptocheirus, Gammaropsis togoensis, Photis lamellifera*) certainement lessepsiennes.

Un indice faunistique significatif est donné par le rapport des espèces de Lysianassidae et celui des espèces de Talitroidea au nombre total des Gammaridae. L'indice des Lysianassidae est en Méditerranée de 13,2 (12,3 dans la faune indo-pacifique, 24,7 dans la faune atlantique septentrionale, 20,9 dans la faune antarctique). L'indice des Talitroidea est en Méditerranée de 5,9 (4,3 dans la faune indo-pacifique, 1,9 dans la faune atlantique septentrionale, 1,3 dans la faune antarctique). Les indices, faible pour les Lysianassidae et élevé pour les Talitroidea, mettent en évidence l'importance de la composante subtropicale de la faune méditerranéenne des Amphipodes.

Un autre caractère très significatif est le nombre élevé des espèces endémiques de Méditerranée, 176, soit environ 39% de la faune globale. L'importance de l'endémisme méditerranéen est souligné par le fait que 10 genres sur les 165 relevés en Méditerranée sont endémiques : *Aurobogidiella, Marinobogidiella, Longigammarus, Lunulogammarus, Neogammarus, Rhinolabia, Degocheirocratus, Parunciola, Pedoculina, Pseudolirius*. Si on ajoute à ces derniers que huit genres, tous indo-pacifiques sont représentés avec des espèces endémiques en Méditerranée, mais non en Atlantique est (*Cheirophotis, Aroui, Ensayara, Onesimoides, Prachynella, Arculfia, Pardaliscoides, Ileraustroe, Unciolella*), la composante endémique de la Méditerranée se caractérise fortement par rapport à celle de l'Atlantique.

Si l'on excepte les 21 espèces cosmopolites, les 8 espèces lessepsiennes et *Pardaliscoides tenellus*, connue de Méditerranée et du Pacifique méridional mais dont l'attribution est douteuse, les autres 247 espèces qui représentent environ 55% de la faune, sont présentes aussi en Atlantique : 27 sont maurétaniennes, 38 maurétano-lusitaniennes, 55 lusitaniennes, 9 lusitano-boréales, 80 atlanto-méditerranéennes avec une plus ample distribution latitudinale en Atlantique et 34 enfin sont boréo-méditerranéennes. Les espèces boréo-méditerranéennes sont particulièrement intéressantes avec leur distribution discontinue, elles sont présentes dans l'Atlantique septentrional au maximum jusqu'aux côtes atlantiques françaises et en Méditerranée, un bon nombre d'entre elles sont des espèces bathyales. Il n'est pas exclu qu'un nombre non négligeable de ces discontinuités de distribution corresponde à des lacunes de connaissance. Néanmoins une telle composante froide s'oppose ou complète, dans un certain sens, la composante tropicale.

Il est nécessaire de rappeler que les espèces atlanto-méditerranéennes peuvent avoir leur centre d'évolution aussi bien en Atlantique qu'en Méditerranée. Le genre *Ichnopus* ne comprend que des espèces indo-pacifiques et les deux atlanto-méditerranéennes, il est donc probable que la colonisation de l'Atlantique par ces deux espèces se soit faite à partir d'un centre d'évolution méditerranéen. Il en est probablement de même pour une bonne partie des Ampithoidae, Gammaridae, Hyalidae, Melitidae, Podoceridae et Talitridae.

La composante lessepsienne est seulement de 8 espèces : *Cymadusa filosa, Bemlos leptocheirus, Unciolella lunata, Gammaropsis togoensis, Photis lamellifera, Elasmopus pectenicrus, Maera hamigera, Stenothoe gallensis*. Il n'est pas certain que toutes ces espèces soient entrées à travers le Canal de Suez (cette probabilité est quasi-absolue en ce qui concerne les espèces limitées à la Méditerranée orientale) car certaines d'entre elles sont aussi présentes dans l'Atlantique tropical.

Ce cadre faunistique permet d'indiquer que la part la plus nombreuse de la faune méditerranéenne est d'origine atlantique, postmessinienne, comme cela est démontré par le fort contingent d'espèces communes avec l'Atlantique, mais aussi par un bon nombre d'espèces endémiques vicariantes d'espèces atlantiques (par exemple *Cressa mediterranea/C. dubia*). A ce contingent appartient la composante boréo-méditerranéenne qui représente la fraction pénétrée en Méditerranée durant les phases quaternaires froides. Il y a dans ce cas aussi, probablement, quelques endémiques méditerranéennes vicariantes d'espèces atlantiques boréales.

Il existe en Méditerranée à côté de cette composante atlantique, une composante indo-pacifique notable qui représente outre la fraction constituée par les introductions lessepsiennes récentes, la partie la plus ancienne (prémessinienne ?) de la faune des Amphipodes de Méditerranée, une partie de la faune endémique dont l'affinité indo-pacifique se situe actuellement au niveau générique semblerait être issue de cette faune.

RÉFÉRENCES

RUFFO S (Ed.), BELLAN-SANTINI D., KARAMAN G., KRAPP-SCHICKEL G., LEDOYER M., MYERS A., RUFFO S., SCHIECKE U., 1982. The Amphipoda of the Mediterranean. Part 1 : Gammaridea (Acanthonotozomatidae to Gammaridae). Mémoires de l'Institut océanographique, Monaco, 13 : 1-364

RUFFO S. (Ed), BELLAN-SANTINI D., DIVIACCO G., KRAPP-SCHICKEL G., MYERS A., RUFFO S., 1989. The Amphipoda of the mediterranean. Part 2 : Gammaridea (Haustoriidae to Lysianassidae). Mémoires de l'Institut océanographique, Monaco, 13 : 365-576.

RUFFO S. (Ed.),BELLAN-SANTINI D., KARAMAN G., KRAPP-SCHICKEL G., LEDOYER M., RUFFO S., 1993. The Amphipoda of the mediterranean. Part 3 : Gammaridea (Melphidippidae to Talitridae), Ingolfiellidea; Caprellidea. Mémoires de l'Institut océanographique, Monaco, 13 : 577-813.

APERÇU DE BIONOMIE BENTHIQUE ET RÉPARTITION DES DIFFÉRENTS FACIÈS DE LA ROCHE LITTORALE À HANNOUCH (LIBAN-MÉDITERRANÉE ORIENTALE)

Ghazi BITAR et Souha BITAR-KOULI

Université libanaise, Faculté de Santé Publique (Section I), Beyrouth, Liban

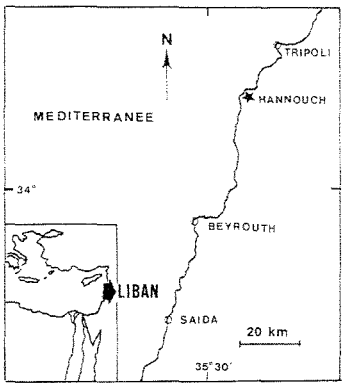


Fig. 1. Localisation de la station étudiée ★

Contrairement au domaine pélagique, le benthos de la côte libanaise est très mal connu. Dans le cadre de la bionomie benthique et de la cartographie des peuplements superficiels de substrats rocheux, nous avons prospecté, en plongée sous- marine et à l'aide d'un scaphandre autonome, la région de Hannouch à environ 65 km. au nord de Beyrouth (Fig. 1). Cette zone éloignée de toute agglomération a été choisie comme "zone de référence". Elle est ouverte au large et frappée de plein fouet par les vents dominant de secteur ouest. En se basant sur le système d'étagement de l'école d'Endoume (PERES, 1982) le profil topographique des trois premiers étages (Fig. 2) présente, de haut en bas, les espèces caractéristiques et les faciès suivants.

Etage supralittoral : La roche carbonatée, haute de 5 m. présente deux parties. Une partie horizontale est caractérisée par la présence des mares et reçoit les embruns en cas de mer forte (Fig. 2, A). La deuxième est une falaise déchiquetée dans les trois premiers mètres et caractérisée par la présence des Cyanobactéries et des Lichens *Verrucaria symbalana* qui donnent àla roche une teinte sombre. Dans les alvéoles se trouvent deux Gastéropodes, *Littorina punctata* et *Melaraphe neritoides*. Les isopodes *Ligia italica* caractéristiques de cet étage s'y trouvent par centaines (Fig. 2, B).

Etage médiolittoral : Il se divise en deux parties. La première, en bas de la falaise émergée, est verticale et large de 50 cm. Elle peut se présenter sous forme d'une encoche (Fig. 2, C). Le Cirripède *Chthamalus stellatus* est caractéristique de cette zone au niveau de laquelle on trouve beaucoup de Patelles. La deuxième partie constitue une "plate-forme de Vermets" (Fig. 2, D). Large de 1 à 20 m. selon l'endroit, ce platier nommé trottoir par SANLAVILLE (1977) et situé un peu au dessus du niveau moyen de la mer, est constitué généralement de vasques peu profondes (5 à10 cm.) et colonisé par les Vermets *Vermetus triqueter* et les Bivalves lessepsiens *Brachidontes variabilis*. Sur les crêtes inter-vasques, construites par les vermets *Dendroproma petraeum* (SANLAVILLE, 1977) on trouve *Chthamalus stellatus, Patella sp.* et *Monodonta turbinata*. Dans les cuvettes de 30 à50 cm. on trouve *Sargassum vulgare* et *Cystoseria compressa*. Le rebord externe de la plate-forme constitue un bourrelet surélevé d'environ 20 cm par rapport au platier. Il s'agit d'un concrétionnement bioconstruit par *Dendropoma petraeum*. A ce niveau, on trouve une ceinture de *Laurencia papillosa* avec *Corallina elongata* et *Jania rubens* (Fig. 2, E).

Etage infralittoral : sa limite supérieure est le bourrelet qui, dans cet endroit agité, présente des "mares en balconnets" (SANLAVILLE, 1977) ou des replats à *Cystoseria* sp. Ces algues, indicatrices d'eau pure, disparaissaient dans les zones polluées comme à Beyrouth. Au niveau du surplomb formé par le bourrelet, on trouve en plus des Corallines, des éponges calcaires et l'algue *Halimeda tuna* qui prolifère dans les endroits ombragés (Fig. 2, F). En dessous du rebord externe, la roche se présente sous forme d'une falaise allant jusqu'à 6 m. (Fig. 2 G). Elle est tapissée de haut en bas, des faciès suivants : *Corallina elongata* (avec en épiphyte *Falkenbergia rufolanosa*), *Jania rubens, Sargassum vulgare, Dictyopteris membranacea, Dilophus spiralis* et *Padina pavonica*. Dans les zones sciaphiles, on trouve les éponges : *Tylodesma* sp., *Chondrosia reniformis* et *Chondrilla nucula*.

De - 6 m. jusqu'à - 8 m. le profil topographique est sub-horizontal. On y trouve, en plus de *Dictyopteris membranacea*, les faciès à *Colpomenia sinuosa* et à *Stypocaulon scoparium* (Fig. 2, H). On note la présence de *Stypopodium* zonale qui peut, comme dans d'autres secteurs de la côte libanaise, remplacer les autres espèces. Il s'agit d'une algue lessepsienne citée pour la première fois au Liban. A partir de - 8 m., la roche est subverticale jusqu'à - 16 m. (Fig. 2, I). On y assiste aux faciès : *Balanus* sp., *Amphiroa rigida* et *Lytocarpus philippinus* d'origine indopacifique (espèce identifiée par C. MORRI). Cette dernière espèce est nouvelle pour le Liban et la Méditerranée. Par endroits, on trouve les éponges *Ircinia fasciculata* et *Ircinia* sp. dans lesquelles vivent *Hermodice caranculata* (Polychète indopacifique), *Alpheus dentipes* (espèce nouvelle pour le Liban) et de Ophiures. Une algue Squamariacée (à déterminer) est dominante dans ce secteur. A partir de - 16 m. le relief rocheux devient sub-horizontal jusqu'à-25 m. où le fond est recouvert, par endroits, de graviers. Cette profondeur, atteinte lors de nos plongées, est située vers 300 m. de la côte. Dans cette zone on assiste à des éponges dressées dont une appartenant au genre *Axinella*. Les algues *Stypopodium* y sont rares mais de grande taille.

Cette note donne une idée descriptive et qualitative des différents faciès établis dans des "zones à protéger" de la côte libanaise. Elle servira comme référence pour toute étude ultérieure, en particulier, dans le domaine de l'impact de la pollution.

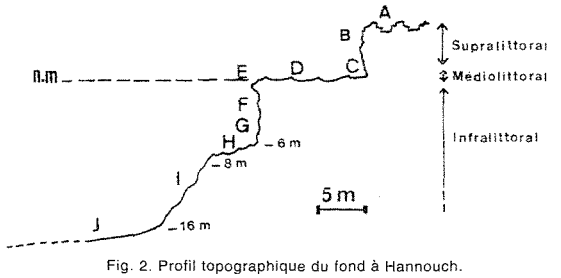


Fig. 2. Profil topographique du fond à Hannouch.

REMERCIEMENTS. Ce travail a pu être achevé grâce à une contribution financière du CNRSL.

REFERENCES

PERES, J. M. , 1982. Chapter 8 : Major benthic assemblages, *in* Kinne O. (ed.). Marine Ecology. A comprehensive integrated treatise on life in oceans and coastal waters. Vol. 5. Ocean management, part 1. Zonations and organismic assemblages. Chichester, New York, Willey : 373-522.

SANLAVILLE, P., 1977. Etude géomorphologique de la région littorale du Liban. Publ. Univ. libanaise, Sect. Etudes géographiques, t. 1 et 2 : 859 p., 43 pl.

IMPACT DE LA POLLUTION SUR LA RÉPARTITION DES PEUPLEMENTS DE SUBSTRAT DUR À BEYROUTH (LIBAN - MÉDITERRANÉE ORIENTALE)

Ghazi BITAR et Souha BITAR-KOULI

Université Libanaise. Faculté de Santé Publique (Section I), Beyrouth, Liban

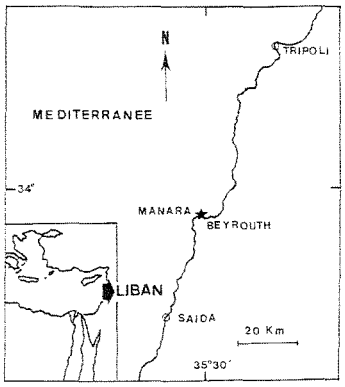


Fig. 1. Localisation de la station étudiée ★

Suite à notre travail à Hannouch (BITAR, 1995) concernant la bionomie benthique et la répartition des peuplements situés dans une zone éloignée de toute agglomération, nous avons choisi la station de Manara afin de voir l'impact de la pollution, surtout urbaine, sur les peuplements littoraux. La station étudiée se trouve sur la rive Nord de la presqu'île de Beyrouth, à proximité du radiophare de l'université américaine (Fig. 1). Affectée seulement par les houles du Nord, la station se situe dans une zone où débouchent en mer, sans aucun traitement et à ciel ouvert, plusieurs égouts tout le long de la Corniche entre Aïn el-Mraissé et Manara. Le profil topographique (Fig. 2) des trois étages, supra, médio et infralittoral ainsi que les faciès correspondants se présentent ainsi.

L'étage supralittoral est représenté par une roche subverticale de 1,5 m. de hauteur au maximum. Comme à Hannouch, les espèces caractéristiques y sont : *Verrucaria symbalana, Littorina Punctata, Melaraphe neritoides* et *Ligia italica*. A l'horizon inférieur de cet étage on trouve rarement *Chthamalus depressus* (Fig. 2, A).

L'étage médiolittoral, comme à Hannouch, montre deux zones : une zone supérieure de 0,5 m. de hauteur en continuité avec la falaise émergée (Fig. 2, B). *Chthamalus stellatus* y est l'espèce caractéristique. Les deux Mollusques *Patella* sp. et *Monodonta turbinata* y sont très rares à cause, certainement, de la pollution et de leur utilisation comme appât par les pêcheurs. La deuxième zone (Fig. 2, C) est représentée par la plate-forme à Vermets *Vermetus triqueter* avec ses vasques colonisées par *Brachidontes variabilis* et *Enteromorpha* sp. Les crêtes inter-vasques sont dominées par *Chthamalus stellatus*. Le rebord externe du platier constitue un bourrelet à *Dendropoma petraeum* sur lesquels se trouvent plusieurs espèces d'algues et en particulier la ceinture de *Laurencia papillosa*. La largeur du platier peut atteindre 7 mètres.

L'étage infralittoral montre selon le profil topographique (Fig. 2) cinq niveaux :

- Niveau D. En dessous du surplomb que peut former le rebord externe du platier, la roche descend jusqu'à 1,5 m. en pente subverticale. En plus de deux faciès à *Corallina elongata* et *Jania rubens*, ce niveau est caractérisé par un dense faciès à *Pterocladia capillacea*. Cette dernière, abondante à Beyrouth, est rare, voire même, absente dans d'autres localités de la côte libanaise. Sa dominance est due aux déversements des égouts qui rendent le milieu riche en matières organiques (BASSON *et al.*, 1976). A la limite supérieure de cet étage on note l'absence des Cystoseires indicatrices d'eau pure.
- Niveau E. Vers - 2 m. de profondeur, on assiste à un platier de 6 m. de largeur. Il est tapissé d'algues : *Corallina elongata, Jania rubens* et *Sargassum vulgare*. En avril, cette zone est quasiment recouverte de *Colpomenia sinuosa*. Par contre la couverture algale est absente en hiver et on aperçoit les faciès à éponges : *Cliona* sp. et *Chondrilla nucula*. Les oursins *Paracentrotus lividus* et *Arbacia lixula* y sont toujours présents.
- Niveau F et G. Entre - 2 m. et - 4 m. de profondeur; le substrat rocheux est subvertical pour devenir surplombant jusqu'au fond atteint à - 8 m. la flore étant représentée par le faciès à *Corallina* et dans les endroits sciaphiles on trouve *Peyssonnelia* sp. et *Lithophyllum incrustans*. En comparaison avec la station de Hannouch (BITAR, 1995) on remarque ici la rareté ou l'absence des faciès à *Dictyopteris, Dilophus et Amphiroa*. Ceux-ci sont remplacés, de haut en bas, par les faciès faunistiques : *Balanus* sp., *Lytocarpus philippinus*, (Hydraire lessepsien et espèce nouvelle pour le Liban), *Phallusia nigra* (Ascidie lessepsienne nouvelle pour le Liban), *Malleus regula* (Bivalve signalée pour la première fois à Beyrouth par ZIBROWIUS et BITAR en 1979) et *Microcosmus exasperatus* (Ascidie de mers chaudes, nouvelle pour le Liban). On remarque que toutes ces espèces sont des animaux filtreurs et leur présence est due à l'abondance des matières organiques provenant des égouts. Par contre, ce niveau est représenté à Hannouch (BITAR, 1995) par des faciès floristiques et des brouteurs.
- Niveau H. Au fond, on assiste tout d'abord, à des éboulis suivis d'un fond rocheux recouvert d'une couche de sable fin avec de la vase. Ce qui empêche l'installation des algues et en particulier *Stypocaulon scoparium*. On note aussi la rareté de l'ophiure *Ophioderma longicauda* (espèce nouvelle pour le Liban) et de l'huître perlière *Pinctada radiata* qui existaient en abondance dans les années soixantes (observation personnelle). Il est fréquent de trouver en abondance sur le fond : des ordures ménagères dans des sacs en plastique, des boîtes de toutes sortes ainsi que des bouteilles en verres provenant soit des gens qui fréquentent la corniche, soit de la localité de Zaïtouneh où se jettent à ciel ouvert les ordures et les déchets de la ville. Ainsi, les rejets de toutes sortes en mer et l'utilisation "interdite" des explosifs et des produits toxiques pour la pêche sont à l'origine de la dégradation des peuplements, de la rareté et de la disparition de plusieurs espèces. Pour cela, il est nécessaire et urgent d'entamer un nouveau projet d'assainissement de la ville qui prévient la déviation de tous les égouts vers une station d'épuration avant de rejeter en mer les eaux traitées au moyen d'un seul égout. Cet égout doit, bien sûr, être loin de la ville et déboucher en profondeur au large de la mer.

REFERENCES

BASSON, P. W., HARDY, J. T. and LAKKIS, V. 1976. Ecology of marine macro-algae in relation to pollution along the coast of Lebanon. *Acta Adriatica*, 18, 19 : 307-325.

BITAR, G., 1995. Aperçu de bionomie benthique et répartition des différentes faciès de la roche littorale à Hannouch. *Rapp. Comm. int., Mer Médit.*, 34.

ZIBROWIUS, H. & BITAR, G., 1981. Serpulida (*Annelida polychaeta*) indopacifiques établis dans la région de Beyrouth, *Liban. Rapp. Comm. int. Mer. Médit.*, 27(2) : 159-160.

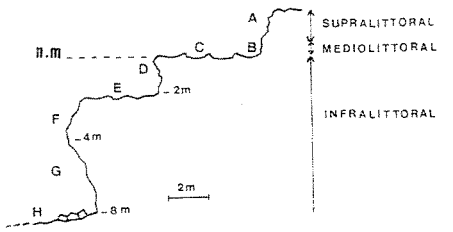


Fig. 2. Profil topographique du fond à El-Manara

B

B

PRELIMINARY DATA ON BATHYMETRIC AND TEMPORAL CHANGES IN THE MORPHOLOGY OF A MALTESE *POSIDONIA OCEANICA* (L.) DELILE MEADOW

Joseph A. BORG & Patrick J. SCHEMBRI

Department of Biology, University of Malta, Msida, Malta

Preliminary data on the morphology of a local *Posidonia oceanica* meadow were obtained as part of an ongoing study on the community structure and composition of the vagile fauna associated with this seagrass. The values for Shoot Density, Leaf Standing Crop and Leaf Area Index obtained appear to be higher than those reported for meadows of this seagrass in other parts of the Mediterranean.

Data on the structure and composition of meadows of *Posidonia oceanica* and on morphological parameters of the plant itself are lacking for the Maltese Islands; the only published data are those of DREW & JUPP (1976). The aim of this study was to provide preliminary data on the morphological characteristics of a local *Posidonia* meadow situated off the White Tower headland, in the Malta-Comino Channel.

Shoot Density was estimated *in situ* by taking five 0.125m^2 quadrats at each of four stations located along a depth gradient at 6 m, 11 m, 16 m and 21 m. Estimates were made in August 1993, December 1993 and April 1994. Number of leaves per shoot, leaf length, and leaf width were measured in the laboratory for 25 shoots chosen at random from each sampling station. The dry weight of the leaf fraction excluding rhizomal weight and the leaf area index were also estimated.

The mean Shoot Density as measured over the whole sampling period showed an overall decrease with depth. Values recorded were: 782 - 807 shoots/m^2 at 6 m, 570 - 657 shoots/m^2 at 11 m, 464 - 530 shoots/m^2 at 16 m, and 357 - 420 shoots/m^2 at 21 m. The number of intermediate and adult leaves per shoot varied between a minimum of 3.9 leaves/shoot recorded at a depth of 16 m in August '93 and a maximum of 6.1 leaves/shoot recorded at a depth of 21 m in December '93. The number of leaves per shoot varied least with depth in December '93 (Fig. 1). The Leaf Area Index (L.A.I.) showed a general decrease with depth (Fig. 2). Maximum values for the Leaf Standing Crop (L.S.C.) were obtained in August '93 (Fig. 3). In general, the Shoot Density values recorded during the present study are higher than those reported by DREW & JUPP (1976) for Malta and by other workers for different regions of the Mediterranean (for example, MAZZELLA *et al.*, 1989 and BUIA *et al.*, 1985). This is also true for the Leaf Area Index. Overall, values of number of leaves per shoot are similar to those reported for other localities (for example, MAZZELLA *et al.*, 1984) and to those of DREW & JUPP (1976) for Malta. The discontinuity in leaf morphological parameters recorded at depths of 10 to 15 m by other workers is most pronounced locally for the Leaf Area Index and this discontinuity probably represents a separation between shallow-water and deep-water meadows (MAZZELLA *et al.*, 1989; CINELLI *et al.*, 1984; MAZZELLA & OTT, 1984). The low L.A.I. and L.S.C. values at 6 m cannot be attributed to sea-urchin grazing as has been suggested by DREW & JUPP (1976) since echinoid density was close to zero in the study area following a sudden large decline in the *Paracentrous lividus* population some four to five years ago. Furthermore, no significant temperature differences were recorded in the 6 to 21 m depth range. We attribute the presence of this discontinuity to different growth patterns of *Posidonia* in response to the varying hydrodynamic regime at different depths in the study area, as has already been suggested for other parts of the Mediterranean (MAZZELLA & OTT, 1984; BUIA *et al.*, 1992).

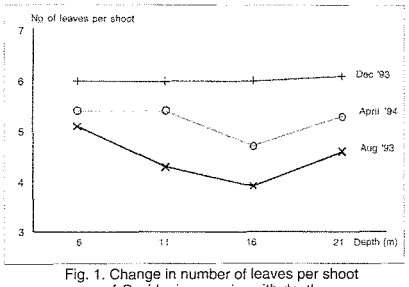


Fig. 1. Change in number of leaves per shoot of *Posidonia oceanica* with depth

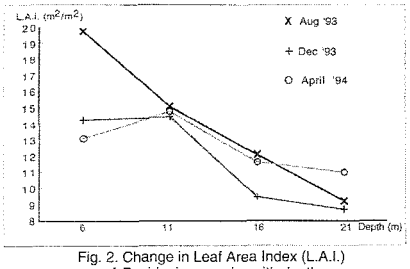


Fig. 2. Change in Leaf Area Index (L.A.I.) of *Posidonia oceanica* with depth

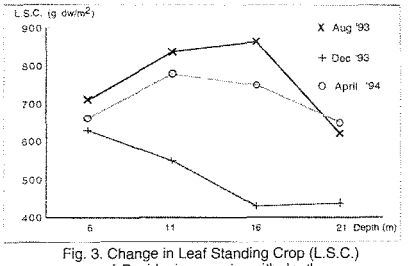


Fig. 3. Change in Leaf Standing Crop (L.S.C.) of *Posidonia oceanica* with depth

REFERENCES

BUIA M. C., CORMACI M., FURNARI G. & MAZZELLA L., 1985. *Posidonia oceanica* off Capo Passero (Sicily, Italy): leaf phenology and leaf algal epiphytic community. *In* : C. F. BOUDOURESQUE, A. MEINESZ, E. FRESI and V. GRAVEZ (eds.), International Workshop on *Posidonia* Beds G.I.S. Posidonie publ., France, 2 : 127-143.

BUIA M. C., ZUPO V. & MAZZELLA L., 1992. Primary growth and dynamics in *Posidonia oceanica*. P.S.Z.N.I. *Marine Ecology*, 13 (1): 2-16.

CINELLI F., CORMACI M., FURNARI G., & MAZZELLA L., 1984. Epiphytic macroflora of *Posidonia oceanica* (L.) Delile leaves around the island of Ischia (Gulf of Naples). *In* : C. F. BOUDOURESQUE, A. JEUDY DE GRISSAC & J. OLIVIER (eds.), *op. cit.*, 1 : 91-99.

DREW E. A. & JUPP B. P., 1976. Some aspects of the growth of *Posidonia oceanica* in Malta. *In* : E. A. DREW, J. N. LITHGOE & J. D. WOODS (eds.), Underwater research : 337-368. Academic Press, U.K.

MAZZELLA L. & OTT A. J., 1984. Seasonal changes in some features of *Posidonia oceanica* (L.) Delile leaves and epiphytes at different depths. *In* : C. F. BOUDOURESQUE, A. JEUDY DE GRISSAC & J. OLIVIER (eds.), *op. cit.*, 1 : 119-127.

MAZZELLA L., SCIPIONE M. B. & BUIA M. C., 1989. Spatio-temporal distribution of algal and animal communities in a *Posidonia oceanica* meadow. P.Z.N.I. *Marine Ecology*, 10 (2) : 107-129.

EPIBENTHIC MACROFAUNAL ASSEMBLAGES AND BOTTOM HETEROGENEITY IN THE SHALLOW INFRALITTORAL OF THE MALTESE ISLANDS

Joseph A. BORG & Patrick J. SCHEMBRI

Department of Biology, University of Malta, Msida, Malta

Marine ecologists have dedicated much time and effort in attempts to distinguish and classify marine benthic communities. In the Mediterranean, the vertical zonation scheme of PÉRÈS & PICARD (1964), as subsequently revised by PÉRÈS (1967; 1982), has been extensively used in spite of a number of difficulties associated with it (BOUDOURESQUE & FRESI, 1976; GOLIKOV, 1985). PÉRÈS (1967, 1982) identifies seven vertical zones, one of which, the infralittoral, represents the vertical extent of occurrence of marine phanerogams and photophilic algae. This zone thus includes some of the most important shallow-water coastal ecosystems. PÉRÈS (1967, 1982) subdivides the infralittoral into a number of biocoenoses and facies. Malta lies in the centre of the Mediterranean, but in spite of its biogeographical interest, only scanty information on the ecology of its coastal benthic communities is available. From preliminary diving surveys, the authors noted that the Maltese infralittoral is very heterogeneous, both physically and biologically. For example, five or more different types of bottom are frequently present within an area of a few square metres. The aim of this study was to obtain information on the structure, composition and distribution of the epibenthic faunal assemblages in the Maltese shallow infralittoral, by studying a cove which is representative of such habitats. The study area, a cove known as Dahlet ix-Xmajjar, is a V-shaped, northwest-facing inlet situated on the northernmost tip of the island of Malta. The cove is moderately exposed, has unpolluted water and is little frequented. Depth varies from 1 m inshore to 15 m at the mouth of the cove. The bottom is very heterogeneous, especially in the innermost part where it consists of a short stretch of bedrock, patches of bare medium to coarse sand, boulders, accumulations of pebbles and cobbles, and meadows of the seagrasses *Cymodocea nodosa* and *Posidonia oceanica*. Along the outer parts of the cove's headlands, the bottom consists of a stretch of bedrock leading to dense *Posidonia* meadows and patches of medium to coarse sand. During the summer of 1990, three transects were laid perpendicular to the shore from mean sea-level to a depth of 25 m. Epibenthic fauna larger than 2 mm were collected by SCUBA divers from 500 cm^2 quadrats positioned along the transects; in all 141 quadrats were sampled. Samples containing one or more of the twenty most abundant species, chosen on the basis of their occurrence in at least 10% of the total samples collected, were analysed statistically by centroid clustering using the Bray-Curtis and the Jaccard coefficients. Collectively, Mollusca and Crustacea formed the bulk of the macrofauna collected (80%, Fig. 1). Both coefficients used gave principal clusters corresponding to the two main types of bottom present in the study area (Fig. 2) : soft sediment with *Posidonia* meadows, and hard substrata with photophilic algae. For the soft sediment/*Posidonia* assemblage, the characteristic species were the gastropods *Smaragdia viridis* and *Tricolia speciosa* whilst for the rock/photophilic algae assemblage, the characteristic species were the gastropods *Rissoa variabilis* and *Columbella rustica*. However, as shown by the number of sub-clusters of quadrats within each main cluster, both bottom types were very heterogeneous due to frequent overlap with other bottom types, namely : bare medium/coarse sand, medium/coarse sand covered with decomposing *Posidonia* debris, bedrock covered with a very thin layer of sand, and sediment with *Cymodocea nodosa*. As a result of the high degree of heterogeneity in bottom type, there was extensive overlap between putative faunal assemblages. A number of species assigned by PÉRÈS (1967, 1982) to particular assemblages were not found to be assemblage-specific in the area studied. These included the decapods *Pagurus chevreuxi*, *Pisa tetraodon* and *Galathea bolivari*, and the gastropods *Bittium latreillii*, *Alvania discors* and *Jujubinus striatus*, all of which were collected on both bedrock and *Posidonia*. In general, of the two most abundant taxa, molluscs were more assemblage specific than crustaceans. These results indicate that substratum type is the main determinant of the faunal composition in the study area and that communities were being assembled primarily on the basis of the substratum preference of their component species, and only secondarily in response to other factors, both biotic and abiotic. While the traditional bionomic schemes are useful in discussing the main infralittoral benthic assemblages which occur over wide areas, they are not as useful when applied at the local level where the bottom is very heterogeneous. Here, micro-edaphic factors seem to be the main ones controlling the structure and composition of faunal assemblages. This study shows that it is not always possible to distinguish discrete faunal assemblages within the shallow infralittoral zone. Rather than attempting to equate infralittoral assemblage types from different geographical areas, it may be more useful for workers to study the key factors which determine the structure of the infralittoral assemblages of a particular locality and how these differ from those important in other localities.

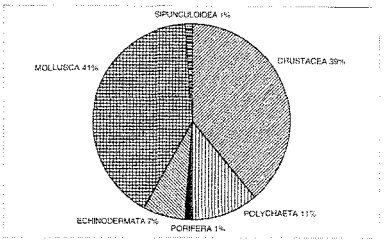


Fig. 1. Relative composition of the fauna calculated on the basis of number of individuals collected.

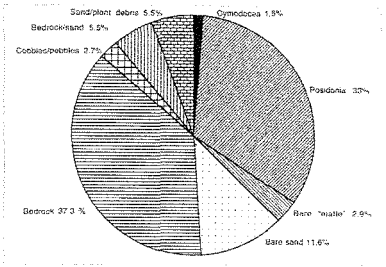


Fig. 2. Relative abundance of different bottom types along the transects

REFERENCES

BOUDOURESQUE C. F. & FRESI E. 1976. Modelli di zonazione del benthos fitale in Mediterraneo. *Boll. Pesca Piscic. Idrobiol.* 31 : 129-143.

GOLIKOV A. N. (1985). Zonations and organismic assemblages : comments on the comprehensive review by Pérès. *Mar. Ecol. Prog. Ser.* 23 : 203-206.

PÉRÈS J. M. (1967). The Mediterranean benthos. *Oceanogr. Mar. Biol. Ann. Rev.*, 5 : 449-533.

PÉRÈS J. M. (1982). Zonations and organismic assemblages. *In* O. KINNE (ed.) Marine ecology, Vol 5(1) Ocean management, pp 9-642. J. Wiley & Sons, New York.

PÉRÈS J. M. & PICARD J. (1964). Nouveau manuel de bionomie benthique de la mer Mediterranée. *Rec. Trav. Sta. Mar. Endoume* 31 (47) : 5-137.

ARRACHAGE DES FAISCEAUX DE *POSIDONIA OCEANICA* PAR LES ANCRES : UN PROTOCOLE D'ÉTUDE

Charles F. BOUDOURESQUE[1], François ARRIGHI[2], Franck FINELLI[2] et Jean-Robert LEFEVRE[1]

[1] LBMEB et EP CNRS N° 75, Faculté des Sciences de Luminy, 3288 Marseille cedex 9, France.
[2] Parc Naturel Régional de la Corse, Maison de la Mer, 20245 Galeria, France

De nombreux auteurs ont signalé que l'herbier à *Posidonia oceanica* (Linnaeus) Delile était dégradé dans les "mouillages forains", zones où s'ancrent les bateaux de plaisance (BOUDOURESQUE et MEINESZ, 1982 ; PORCHER, 1984 ; etc). L'arrachage des faisceaux de *P. oceanica* par les ancres semble en être la cause principale, bien qu'il n'ait pas été quantifié. C'est l'objectif du protocole expérimental que nous proposons.

L'étude a été réalisée en juillet 1991 dans la marina d'Elbu (1.3 ha), un mouillage forain de la Réserve de Scandola (entre Calvi et Portu, Parc naturel régional de la Corse). La densité des faisceaux est comprise entre 440 et 940 faisc./m^2. Les paramètres suivants ont été considérés : (i) longueur du bateau, (ii) type de l'ancre, (iii) présence d'un guindeau électrique assurant la remontée de l'ancre, (iv) profondeur d'ancrage, (v) longueur sur laquelle l'ancre a été traînée avant de s'immobiliser, lors de la descente, (vi) longueur de la chaîne en contact avec le fond, (vii) longueur sur laquelle l'ancre a été traînée sur le fond avant de le quitter, lors de la remontée. Un plongeur assiste à la descente et à la remontée de l'ancre. Il balise les points remarquables du parcours de l'ancre et de la chaîne au moyen de piquets en plastique et de ruban coloré. Une fois l'ancre immobilisée ou remontée, le plongeur procède au comptage des faisceaux arrachés (les faisceaux cassés, même incomplètement détachés, sont comptabilisés).

Le nombre de faisceaux arrachés par cycle d'ancrage (descente et remontée de l'ancre) apparaît comme très variable : entre 0 et 51 faisceaux (Tabl. I). Bien que nos données soient très préliminaires (notre objectif est avant tout de présenter un protocole méthodologique), le nombre de faisceaux arrachés ne semble pas corrélé à la profondeur d'ancrage, ni à la longueur du bateau.

Le nombre moyen de faisceaux arrachés par cycle d'ancrage (17) peut paraître modeste. Toutefois, si l'on considère que le nombre moyen de bateaux au mouillage l'après-midi est de 21 en juillet et de 18 en août, que le nombre total de bateaux ayant mouillé à un moment ou un autre sur 24 h est le double, que la fréquentation totale des 10 autres mois de l'année représente l'équivalent du mois de juillet, et que 13% des plaisanciers s'y reprennent à deux fois pour mouiller, le nombre total de cycles d'ancrage en une année moyenne serait de l'ordre de 4000, soit environ 68 000 faisceaux arrachés.

Longueur bateau (m) et type d'ancre	Profondeur (m)	Descente de l'ancre				Remontée ancre			Total faisceaux arrachés
		Traînée ancre (m)	Longueur chaîne (m)	Faisceaux arrachés		Traînée ancre (m)	Faisceaux arrachés		
				Ancre	Chaîne		Ancre	Chaîne	
8 S	4	0	2	2	0	5	24	0	26
8 S	4	0	3	0	0	1	2	1	3
8 S	4	2	2	24	0	3	27	0	51
12 SE	4	dm	10	0	28	dm	dm	dm	38
12 SE	4	dm	10	dm	8	dm	dm	dm	21
12 C	4	0	15	0	6	dm	dm	dm	16
8 S	5	0	3	0	0	1	3	0	3
8 S	6	0	3	0	0	1	1	0	1
8 S	6	0	5	0	0	1	2	0	2
12 S	8	1	2	0	0	7	0	0	0
8 S	8	0	3	0	0	1	12	0	12
12 S	8	0	4	3	0	dm	dm	dm	13
8 S	14	7	6	0	0	3	13	0	13
8 S	14	dm	dm	dm	dm	0	6	0	13
8 S	14	20	6	9	0	1	5	0	14
14 SE	14	dm	21	dm	18	0	4	8	30
8 S	15	7	7	9	0	2	14	1	24
Moyenne				3.4	3.8		8.7	0.8	16.7

Tableau I : Nombre de faisceaux de *Posidonia oceanica* arrachés par les ancres et les chaînes. Pour le calcul du total des faisceaux arrachés par cycle d'ancrage (dernière colonne), les données manquantes ont été remplacées par la valeur moyenne. S = ancre à sable. C = ancre charrue. E = bateau équipé d'un guindeau électrique pour remonter l'ancre. dm = donnée manquante.

L'arrachage des faisceaux ne représente toutefois qu'une partie de l'impact des ancrages. Par mer agitée, lorsque les bateaux passent la nuit au mouillage, les chaînes glissent latéralement sur plusieurs mètres de part et d'autre de leur position moyenne. De nombreuses feuilles sont arrachées, et certains faisceaux ont leur point végétatif écrasé ou broyé. Leur survie paraît douteuse et devra donc être suivie.

REMERCIEMENTS. Ce travail a été réalisé dans le cadre d'un programme de recherche du Comité scientifique de la Réserve de Scandola (Parc naturel Régional de la Corse), géré par le GIS Posidonie.

RÉFÉRENCES

BOUDOURESQUE C.F. et MEINESZ A., 1982. Découverte de l'herbier de Posidonie. Cah. Parc national de Port-Cros, 4 : 1-79.

PORCHER M., 1984. Impact des mouillages forains sur les herbiers à *Posidonia oceanica*. International Workshop on *Posidonia oceanica* beds, BOUDOURESQUE C.F., JEUDY DE GRISSAC A., OLIVIER J. édit., GIS Posidonie publ., Fr., 1 : 145-148.

VARIATIONS SAISONNIÈRES DES BIOMASSES (FEUILLES ET ÉPIPHYTES) DE *POSIDONIA OCEANICA* (L.) DELILE DANS L'HERBIER DE L'ANSE DE KOUALI (TIPAZA) ALGÉRIE : DONNÉES PRÉLIMINAIRES

BOUMAZA Salima et SEMROUD Rachid

Institut des Sciences de la Mer et de l'Aménagement du Littoral, BP 54, Sidi Fredj 42321, W. Tipaza, Algérie

Les données sur les biomasses de *Posidonia oceanica* sont relativement nombreuses au nord de la Méditerranée (AUGIER et CHRISTIANI, 1984; MAZZELLA et OTT, 1984; THELIN et BEDHOMME, 1983), mais restent rares sur les côtes nord-africaines (SEMROUD, 1993). L'objectif de ce travail est l'étude de l'importance de la communauté des épiphytes de l'écosystème à *Posidonia* à différentes profondeurs. En effet, des variations de biomasse des feuilles et des épiphytes entre les stations superficielles et la station profonde ont été observées sur un cycle annuel. L'herbier de l'anse de Kouali forme une vaste prairie qui s'étend de 0,3 à 19 m de profondeur. La densité est mesurée à l'aide d'un quadrat de 40 x 40 cm (10 réplicats) et est rapportée au m^2. Vingt rhizomes sont prélevés une fois par mois (juin 1992 à juin 1993) dans quatre stations le long d'un transect: dans le récif-barrière (0,3 m et 0,8 m), à 2 m et à 10 m. Les lots de feuilles obtenus (adultes et intermédiaires), selon GIRAUD (1977), sont débarrassés de leurs épiphytes à l'aide d'une lame de rasoir. Le produit du raclage ainsi que les feuilles sont séchés à poids constant (étuve à 70°C pendant 48 h), puis pesés. La biomasse est exprimée en poids sec par mètre carré (g PS.m^{-2}). Les résultats sont donnés pour le total des feuilles (adultes et intermédiaires). Le nombre de faisceaux par m^2 est de 898 (0,3 m), 725 (0,8 m), 640 (2 m) et 386 (10 m). La biomasse des feuilles et des épiphytes par m^2 augmente avec la profondeur (Fig. 1 et 2), mais le phénomène s'inverse à 10 m.

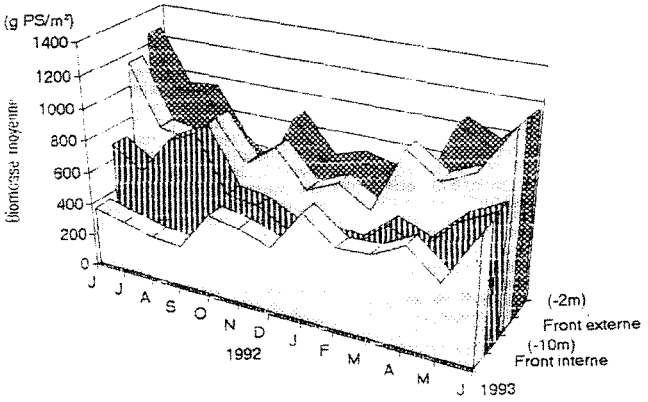


Fig. 1. Variations mensuelles des biomasses moyennes/m^2 des feuilles en fonction de la profondeur.

Les valeurs maximales des biomasses foliaires s'observent généralement à la fin du printemps et au début de l'été pour l'ensemble des stations, excepté pour la station 10 m où elles apparaissent à la fin de l'été. Les valeurs minimales des biomasses foliaires sont relevées dès l'automne et se maintiennent tout l'hiver, sauf pour la station 10 m où elles sont relevées un peu plus tard en hiver. Il apparaît donc un décalage saisonnier des valeurs maximales et minimales des biomasses foliaires en fonction de la profondeur. La biomasse des épiphytes présente un grand écart entre les maxima et les minima pour l'ensemble des stations. Les valeurs maximales sont relevées en été pour les quatre stations avec un second pic au printemps dans le front interne. Les valeurs minimales sont relevées en hiver pour l'ensemble des stations, ce qui correspond à la période de la chute des feuilles.

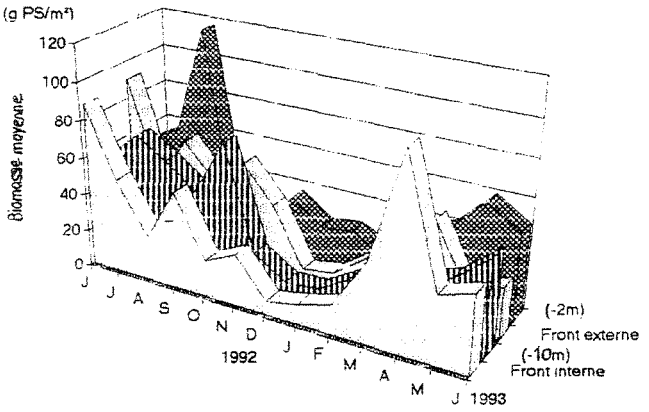


Fig. 2. Variations mensuelles des biomasses moyennes/m^2 des épiphytes en fonction de la profondeur.

RÉFÉRENCES

AUGIER G., CHRISTIANI G., 1984. Indice foliaire et biomasse de l'herbier de Posidonies de la zone de Carry-Sausset (côte bleue, Bouches-du-Rhône, France). International Workshop *Posidonia oceanica* Beds, Boudouresque C.F., Jeudy de Grissac A., Olivier J. (éds.), GIS Posidonie pub., Fr., 1 : 245-254.

MAZZELLA L., OTT J.A., 1984. Seasonal changes in some features of *Posidonia oceanica* (L.) Delile leaves and epiphytes at different depths. International Workshop *Posidonia oceanica* Beds, Boudouresque C.F., Jeudy de Grissac A., Olivier J. (éds.), GIS Posidonie pub., Fr., 1 : 119-127.

SEMROUD R., 1993. Contribution à la connaissance de l'écosystème à *Posidonia oceanica* (L.) Delile dans la région d'Alger (Algérie) : étude de quelques compartiments. Thèse Doct. Etat, Univ. U.S.T.H.B., Alger, Alg. : 1-219.

THELIN I., BEDHOMME A.L., 1983. Biomasse des épiphytes des feuilles de *Posidonia oceanica* dans un herbier superficiel. *Rapp. Comm. int. Mer Médit.*, 28 (3) : 125-126.

B

PHÉNOLOGIE DE *POSIDONIA OCEANICA* (L.) DELILE DANS L'HERBIER DE L'ANSE DE KOUALI, (TIPAZA), ALGÉRIE

BOUMAZA Salima et SEMROUD Rachid

Institut des Sciences de la Mer et de l'Aménagement du Littoral,
BP 54, Sidi-Fredj 42321, W. Tipaza, Algérie

Cette note présente les résultats de la phénologie de *Posidonia oceanica* de l'herbier de l'anse de Kouali. L'étude conduite sur un cycle annuel a porté notamment sur la lépidochronologie, la biomasse et la production primaire. Nos résultats sont comparés avec ceux obtenus par d'autres auteurs dans différents secteurs de la Méditerranée où l'herbier se caractérise par la présence d'un paysage particulier : le récif- barrière.

L'anse de Kouali est située dans la région de Tipaza à l'ouest d'Alger (70 km). Cette station est particulière par la présence d'un récif-barrière qui se continue par un herbier florissant de type "progressif" dont la limite inférieure est située à -19 m.

La densité est mesurée *in situ* à l'aide d'un quadrat de 40 x 40 cm (10 réplicats). 20 rhizomes sont récoltés tous les mois, de juin 1992 à juin 1993, le long d'un transect dans quatre stations :

- Station F. int.: sur le front interne du récif-barrière à *Posidonia oceanica* (-0,3m) délimitant un lagon à *Cymodocea nodosa* et *Zostera noltii*,
- Station F. ext. : sur le front externe du récif barrière (-0,8m),
- Station -2 m : située en avant du récif-barrière,
- Station -10 m : herbier continu jusqu'à l'entrée de l'anse.

Les paramètres phénologiques étudiés sont le nombre de feuilles par faisceau, les longueur et largeur des différentes catégories de feuilles (juvéniles, intermédiaires et adultes, selon la classification de GIRAUD, (1977), L.A.I. (Leaf Area Index) et le coefficient "A" (GIRAUD, 1977)).

Profondeur	F. int. (-0,3m)	F. ext. (-0,8m)	(- 2m)	(- 10m)
Densité (Nb. faisceaux/m²)	898	725	640	386
Nombre de feuilles	4,8	5,4	6,2	6,5
Longueur des feuilles (mm)				
Feuilles adultes	286,6	528,3	534,5	606,3
Feuilles intermédiaires	161,3	294,6	306,2	317,4
Feuilles juvéniles	6,1	5,1	5,5	6
Largeur des feuilles (mm)				
Feuilles adultes	8,6	9,8	10,4	10,8
Feuilles intermédiaires	8,3	9,4	9,9	10,2
Feuilles juvéniles	3,5	2,5	2,7	2,8
Longueur du pétiole (mm)	18,3	30,2	32,1	33,7
Coefficient "A" (en %)				
Feuilles adultes	66,9	78,1	97,8	67,4
Feuilles intermédiaires	10,2	13	14	9,6
Global (Adulte+Intermédiaire)	48,7	60,2	57,9	45,1
Leaf Area Index (Faisceau/cm²)	105,2	236,2	274,9	345,7
Leaf Area Index (m²/m²)	9,4	17,4	18,7	13,3

Tableau 1. Valeurs moyennes annuelles des paramètres phénologiques dans l'herbier de l'anse de Kouali entre juin 1992 et juin 1993.

Les résultats obtenus (Tableau 1) sont comparables à ceux des herbiers dans d'autres régions de la Méditerranée pour des profondeurs équivalentes (Tableau 2). Toutefois, les valeurs de L.A.I./faisceau sont plus importantes dans notre cas, principalement au niveau du récif-barrière.

	Pergent et al.,1988			Giorgi et al.,1983			Pergent et al.,1988		
	Port-Cros			Port-Cros			Urla (Izmir)		
Profondeur	(-0,7m)	(- 2m)	(- 11m)	(0,3m)	(-0,7m)	(- 2,2m)	(0,3m)	(0,8m)	(- 2m)
Densité (Nb. faisceaux/m²)	942	645	317	904	906	640	528	1129	510
Nombre de feuilles	5,1	5,8	5,4	4,8	5,1	5,5	5,3	5,8	6,4
Longueur des feuilles (mm)				240,2*	293,8*	316,3*			
Feuilles adultes	386	401	395				226	403	355
Feuilles intermédiaires	272	306	258				155	243	239
Largeur des feuilles (mm)				9*	8*	9,5*			
Feuilles adultes	9,4	10	10,5				8,7	9,8	9,9
Feuilles intermédiaires	9	9,6	10,2				8,4	9,4	9,4
Longueur du pétiole (mm)	30,6	32,9	34,9	29,9	34,4	43	20,6	29,8	28,2
Coefficient "A" (en %)									
Feuilles adultes	73,7	64,6	27,5				81,7	78,6	74
Feuilles intermédiaires	29,3	27	3,8				13,4	11,2	11,2
Global (Adult+Interm)	57,5	51,2	19,2				54,1	51,4	48,1
Leaf Area Index (Faisceau/cm²)	87	153	13,3	91	121	166	91	187	192
Leaf Area Index (m²/m²)	8,2	9,9	4,2	8,2	11	10,6	4,8	21,2	9,8

Tableau 2 . Paramètres phénologiques relevés dans la littérature pour différentes localités et profondeurs. (*) valeurs globales.

RÉFÉRENCES

PERGENT G. et PERGENT MARTINI C., 1988. Phénologie de *Posidonia oceanica* (Linnaeus) Delile dans le bassin méditerranéen. *Ann. Inst. océanogr.* Paris, Fr, N.S., 64 (2) : 79-100.

GIORGI J. et THELIN I., 1983. Phénologie, biomasse et production primaire de *Posidonia oceanica* (feuilles et épiphytes) dans la baie de Port-Cros. D.E. Ecol. médit., Univ. Aix-Marseille II, Fr. : 1-126.

GIRAUD G., 1977. Contribution à la description et à la phénologie quantitative des herbiers à *Posidonia oceanica* (L.) Delile. Thèse Doct. 3ème cycle, Univ. Aix-Marseille II, Fr. : 1-150.

FISHERY AND BIOLOGY OF *ARISTEUS ANTENNATUS*, RISSO 1816 ON MAJORCA ISLAND WATERS

Aina CARBONELL and Franco ALVAREZ

I.E.O. Centro Oceanográfico de Baleares. Apdo. 291, 07080 Palma de Mallorca, Spain

The deep water shrimp *Aristeus antennatus* is the deepest exploited species of the Western Mediterranean and one of the most important resources for the bottom trawl fishing fleet of the Majorca Island where 40 vessels out of 60 specialise in fishing for shrimp. Although the catches constitute only 5–7 % of the total catch, it is among the main species, in terms of commercial importance, reaching more than 25 % total incomes. The shrimp is mainly fished between 400 and 850 meters depth on muddy bottoms. We study here some biological aspects of *A. antennatus* in the Western Mediterranean, carried out in Majorca, analysing growth and reproductive aspects. A total of 6212 females and 1960 males of *A. antennatus* were collected by commercial bottom–trawl gear during 1992, from sampling carried out monthly and quartely during the reproduction period, either on board commercial trawlers or from landings. Sex, maturity stage and size (carapace length, in mm, taken the right orbital margin to the mid posterior edge of the carapace) were taken. The annual length frequency distribution, obtained from the monthly samplings performed, showed a range of exploited size comprised between 15 to 61 mm Lc in females and 15 to 38 mm in males. The mean size was 36 mm in females and 26 mm in males (fig. 1).

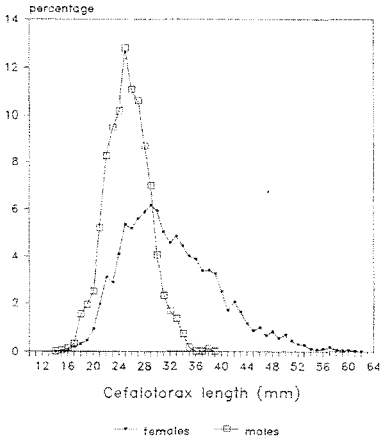


Fig.1. Mean-year length frequency distribution

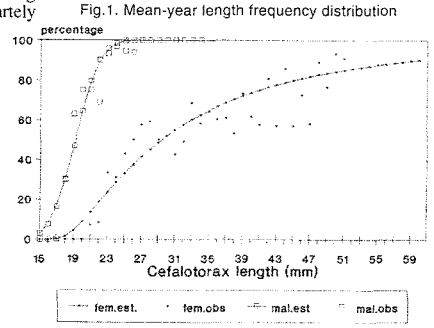


Fig.2. Maturity as a function of length

The size at first maturity was estimated by running the program LIONOR and was found to be 29 mm in females and 19 mm in males (fig. 2). The reproduction period last several months, from April to October. The highest proportion of spawing females was found during June, July and August (fig. 3). The sex ratio estimated from catches was very far from the relation-ship 1:1, females constituted the major part of the catch, between 87 and 61% (fig. 4). The parameters of the length–weight relationship were estimated from the sampling mentioned above and were :

	a	b	r	n
females	0.00299	2.4139	0.9491	2447
males	0.00511	2.1470	0.9079	630

Parameters of the von Bertalanffy growth equation Loo and k were estimated for each sex by running the program ELEFAN (GAYANILO *et al.*, 1988) on the overall size distribution:

	L_{oo} mm	k yr^{-1}	t_0
females	74.0	0.38	0.07
males	46.0	0.47	0.13

The results obtained for the monthly evolution of the gonadosomatic index (GSI) and the percentage of mature specimens are very similar to those obtained in other areas of the Western Mediterranean. Growth of the population showed females growing at a relatively slower rate than males. All this results show that the population of *A. antennatus* is overexploited as in other areas of the Western Mediterranean.

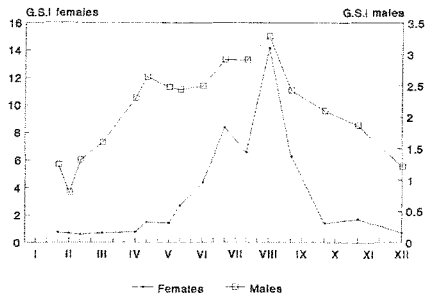


Fig.3. monthly evolution of gonadosomatic index by females anf males

REFERENCES

DEMESTRE M. & LLEONART J., 1993. *Sci. Mar.*, 57(2–3) : 183–189.

DEMESTRE M. & MARTIN P.,1993. *Sci. Mar.*, 57(2–3):175–182.

MARTINEZ BAÑO P. *et al.*, 1988. *Bentos*, 6 : 235–243.

RELINI ORSI L. & RELINI G., 1979. *Quad. Civica Staz. Idrobiol.* Milano, 7 : 39.

RIBEIRO CASCALHO A. & ARROBAS I., 1982. ICES C.M. 1982/K : 6, 23 pp.

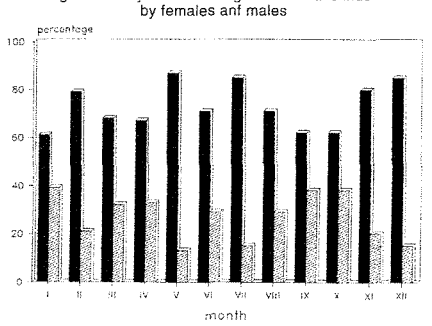


Fig.4. proportion of males and females

ACOMPANYING FAUNA OF THE SHRIMP (*ARISTEUS ANTENNATUS*) FISHERY OFF MAJORCA ISLAND (NW MEDITERRANEAN)

Aina CARBONELL, Enric MASSUTÍ, Olga REÑONES and Franco ALVAREZ

I.E.O. Centre Oceanogràfico de Balears. Apdo. 291, 07080 Palma de Mallorca, Spain

The muddy bottoms in the middle slope off south Majorca between 400 and 800 m depth, have been exploited by trawling nets since the beginning of the 1960's (OLIVER & DAROCA, 1975). It is a monospecific fishery directed, almost exclusively, to the capture of red shrimp (*Aristeus antennatus*) and their landings have oscillated, since 1960, between 130 and 440 tonnes (OLIVER & CARBONELL, 1992).

A research project os this species has been carried out since 1991. This paper describes the accompanying fauna of *A. antennatus* from 12 samplings carried out on board commercial fishing boats dedicated to their exploitation. The hauls were made betweeen 400 and 750 m depth, with a duration from 360 to 450 minutes.

A total of 79 species (60% fishes, 24% crustaceans aznd 16% cephalopods) have been captured (Table 1). The majority of these species are not of commercial interest and are discarded. Others are captured very occasionally but in too small quantity to be commercial, and only some of them could be considered as a by–catch of the fishery : *P. blennoides, M. poutassou, M. merluccius, G. melastomus, A. foliacea, N. norvegicus, G. longipes* and *Plesionika* spp. However, this by–catch is of little importance if it is considered that the object species of interest represents more than 50% of the commercial capture (a mean value of 60%, between 25% and 85%), with this percentage increasing if the economic value is considered.

FISHES	Macroramphosus scolopax	Trachyscorpia c. echinata	Nephrops norvegicus
Galeus melastomus	Coelorhyncus coelorhynchus	Peristedion cataphractum	Polycheles typhlops
Dalatias licha	Hymenocephalus italicus	Lepidorhombus boscii	Palinurus mauritanicus
Etmopterus spinax	Nezumia aequalis	Symphurus ligulatus	Munida perarmata
Chimaera monstrosa	Merluccius merluccius	Symphurus nigrescens	Paramola cuvieri
Alepocephalus rostratus	Gadiculus argenteus	Lophius piscatorius	Macropipus tuberculatus
Argyropelecus hemigymnus	Micromesistius poutassou		Geryon longipes
Chauliodus sloani	Molva d. macrophthalma	CRUSTACEANS	
Stomias boa	Phycis blennoides	Aristaeomorpha foliacea	CEPHALOPODS
Chlorophthalmus agassizii	Lepidion lepidion	Aristeus antennatus	Neorossia caroli
Bathypterois mediterraneus	Mora moro	Solenocera membranacea	Rondeletiola minor
Benthosema glaciale	Hoplostethus mediterraneus	Parapenaeus longirostris	Chtenopteryx sicula
Lampanyctus crocodilus	Epigonus denticulatus	Funchalia woodwardi	Ancistroteuthis lichtensteinii
Myctophum punctatus	Epigonus telescopus	Sergestes sp.	Histioteuthis bonnellii
Evermannella balbo	Mullus barbatus	Pasiphaea multidentata	Illex coindetti
Notolepis rissoi	Mullus surmuletus	Acanthephyra eximia	Todarodes sagittatus
Paralepis coregonoides	Pagellus acarne	Pleisinika heterocarpus	Chiroteuthis veranii
Nemichthys scolopaceus	Pagellus bogaraveo	Pleisionika martia	Octopus salutii
Nettastoma melanurum	Lepidopus caudatus	Plasionika acanthonotus	Eledone cirrhosa
Conger conger	Synchiropus phaeton	Processa canaliculata	Bathypolypus sponsalis
Notacanthus bonapartei	Helicolenus dactylopterus	Pontocaris lacazei	Argonauta argo

Table 1. Species identified in the trawling fleet catches off south Majorca, between 400 and 750m depth.

The main fishes with a regular presence in the by–catch are *P. blennoides* and *M. poutassou*, shich represent 10% (between 4% and 17%) and 7.5% (between 1% and 24%), respectively, with a size range of 9–46 cm for the first (fig. 1a) and 13–42 cm for the second (Fig. 1b). *M. merluccius* and *G. melastomus* are other species that are not always captured in important quantities. However, the majority of *M. merluccius* catches are specimens of large size (Fig. 1c) that obtain a high price on the market, and *G. melastomus* is a species that is captured in large quantities at these depths especially in areas of little exploitation (MASSUTÍ & OLIVER, 1975).

Among the crustaceans, the species of the genus *Plesionika* have a regular presence, are commercialised together, and are the main important by–catch of the fishery with a mean value of 7% and a range between 2% and 18%. *A. foliacea* is another species that in some SE areas of the Island can represent up to 15% of the shole capture, with a carapace length range between 24 and 66 mm (fig. 1d).

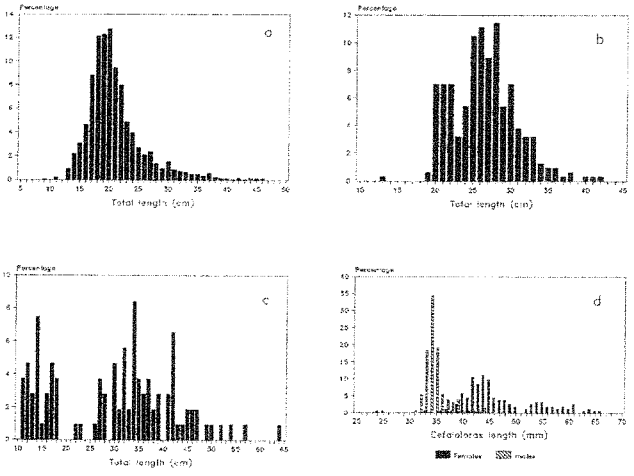


Fig. 1. Size–frequency distributions: a) *P. blennoides* (n=1637). b) *M. poutassou* (n=315). c) *M. merluccius* (n=107). d) *A. foliacea* (b=277)

REFERENCES

MASSUTI, M. & P. OLIVER. 1975. Evolución de la pesca en Baleares entre los años 1970 y 1974. *Publ. Téc. Junta Est. Pesca*, 11: 153–167.

OLIVER, P. & E. DAROCA. 1975. Análisis del esfuerzo para la flota de arrastre del talud de la región Balear. *Bol. Inst. Esp. Oceanog.*, 189 : 1–32.

Oliver, P. & A. CARBONELL. 1992. Analysis of the fluctuations observed on the landings of trawling fleet of the Balearic Islands. *Rapp. Comm. Int. mer Médit.*, 33 : 303.

OBSERVATIONS SUR LA FLORAISON DE BOUTURES DE *POSIDONIA OCEANICA* CULTIVÉES EN AQUARIUM DEPUIS SEPT ANS

Gilberte CAYE, Jérôme BLACHIER et Alexandre MEINESZ

Laboratoire Environnement marin littoral, Université de Nice-Sophia Antipolis, France

Une collection de *Posidonia oceanica* en aquarium a été réalisée en mai 1986 à l'Université de Nice à partir de boutures orthotropes. Celles-ci ont été prélevées entre 3 et 4 m de profondeur dans trois herbiers : à Golfe-Juan et à Villefranche-sur-mer, sur les côtes continentales françaises et autour de l'île de Cavallo dans l'archipel des Lavezzi en Corse. Ce dernier herbier présentait des floraisons fréquentes, suivies de production de fruits; les deux autres herbiers fleurissaient plus rarement et les émissions de fruits étaient encore plus rares (CAYE et MEINESZ, 1984). Au moment de leur récolte, les boutures prélevées en Corse portaient, dans leur bouquet de feuilles, la base d'une hampe florale desséchée témoignant d'une floraison à l'automne précédent (1985). Après deux ans de culture en aquarium, dans les mêmes conditions de substrat (sable coquillé dans des pots de fleur), éclairement en lumière naturelle à des températures de 22°C en juillet-août et 18°C le restant de l'année, les boutures de Corse ont montré le taux de ramification le plus élevé et une apparition plus tardive des racines adventives (MEINESZ *et al.*, 1991). Depuis 1990, la collection réduite à 4 pots par provenance, soit 12 pots contenant chacun une à deux boutures (total de 20 boutures), a été maintenue en culture dans les mêmes conditions. En 1993, ces boutures bien adaptées à la vie en aquarium présentaient un à six apex avec des feuilles de 42 cm à 76 cm de longueur maximum, caractéristiques comparables à celles des posidonies vivant en mer (Tabl. I).

Tableau I. Caractéristiques des boutures de *Posidonia oceanica* en collection dans les aquariums en septembre 1993 (nombre d'apex et type de croissance de l'apex terminal) et en juillet 1993 (longueur maximum des feuilles). * : boutures portant une inflorescence en septembre 1993.

Provenances	N° pots	N° boutures	N° apex	Longueur max. des feuilles (cm)	Type de croissance de l'apex T.
Villefranche	1	1	4	74	plagiotrope
		2	3	60	plagiotrope
	2	1	4	55	plagiotrope
	3	1	2	42	plagiotrope
		2	2	65	orthotrope
	4	1	2	60	plagiotrope
Golfe-Juan	1	1	3	38	orthotrope
	2	1	6	59	plagiotrope
	3	1	3	70	plagiotrope
		2	1	63	plagiotrope
	4	1	4	62	plagiotrope
		2	2	61	plagiotrope
Corse	1	1	1	62	orthotrope*
		2	1	60	plagiotrope
	2	1	2	59	orthotrope
		2	1	76	plagiotrope
	3	1	2	48	orthotrope*
		2	2	52	plagiotrope
	4	1	3	72	orthotrope
		2	2	70	plagiotrope

Sur ces 20 boutures vivant en aquarium depuis plus de sept ans, deux d'entre-elles, originaires de Corse, ont fleuri à l'automne 1993. Les fleurs sont apparues à une semaine d'intervalle (les 13 et 20 septembre) au stade bouton floral, en position terminal sur l'apex principal qui présentait alors une croissance orthotrope. Dans les premiers stades observés, le bouton floral était entouré de bractées vertes; d'abord au nombre de deux, elles se sont multipliées au cours des 15 jours suivants. Trois semaines après le premier stade observé à deux bractées florales, une inflorescence à trois épillets est apparue sur les deux boutures de Corse; le 5 octobre les premières anthères déhiscentes ont été observées. L'inflorescence Corse 3, la plus précoce, présentait sur le premier épillet, en partant de la base, deux fleurs hermaphrodites et une fleur mâle terminale, sur le deuxième, une fleur hermaphrodite et une fleur mâle terminale, et sur le troisième, trois fleurs hermaphrodites. L'inflorescence Corse 1, plus tardive, présentait sur les trois épillets une seule fleur hermaphrodite, avec une fleur mâle terminale sur le premier épillet. Le 11 octobre, l'inflorescence de Corse 3 avait déjà perdu les sacs polliniques de ses anthères alors que l'inflorescence Corse 1 était encore déhiscente. Le 25 octobre, les jeunes fruits verts sont apparus. Ils se sont développés et ont atteint en moyenne 5 mm de long, début novembre. Sur l'inflorescence Corse 3, un fruit situé sur le troisième épillet s'est développé alors très rapidement, présentant 1 cm de long fin novembre. Au contraire, les autres fruits ont arrêté leur développement sur les deux inflorescences. Début décembre, le gros fruit de Corse 3 est tombé et les inflorescences ont commencé à brunir. De janvier à mai 1994, les inflorescences desséchées sont restées attachées aux posidonies, la croissance de l'apex a repris par le développement d'un bourgeon axillaire. La chronologie de la floraison observée en aquarium à partir du 13 septembre 1993 sur deux boutures provenant de Corse fut donc la suivante : le jeune bouton floral à 2 bractées a mis trois semaines pour permettre l'épanouissement de l'inflorescence; la déhiscence des étamines et donc la fécondation se sont déroulées pendant une semaine pour chaque inflorescence (toutes les fleurs n'étant pas mâtures en même temps); après la chute des sacs polliniques, les jeunes fruits se sont développés très rapidement; en 15 jours ils ont atteint 5 mm. Dans cette floraison observée en aquarium, les fruits à peine formés ont montré un arrêt de leur développement qui aurait probablement donné lieu à une chute des inflorescences en mer, sous l'effet de l'hydrodynamisme. Il est en effet fréquent de trouver des inflorescences de *P. oceanica* échouées sur les plages en hiver (PERGENT, 1985; CAYE et MEINESZ, 1984). Ces floraisons en aquarium ont également montré qu'un même apex pouvait porter une floraison à 8 ans d'intervalle (sept. 1985 et 1993); dans les cas observés, ces apex présentaient une croissance orthotrope au moment de leurs floraisons, mais ils avaient traversé une période de 3 à 4 ans en croissance plagiotrope après leur introduction dans les aquariums. La période pouvant séparer les dates de deux floraisons successives sur un même apex est sans doute plus ou moins longue selon les conditions de vie de la plante; par la méthode de la lépidochronologie, une période de 10 années fut également mise en évidence (PERGENT, 1987). Il faut également remarquer que dans les mêmes conditions de vie, ce sont les posidonies de Corse, prélevées dans un herbier dont les floraisons étaient les plus fréquentes, qui ont fleuri en aquarium. Indépendamment des conditions du milieu, l'aptitude à fleurir semble bien être une caractéristique soit héréditaire, soit liée à l'âge des populations ou des individus.

REFERENCES

CAYE G. et A. MEINESZ., 1984. Observations sur la floraison et la fructification de *Posidonia oceanica* dans la baie de Villefranche et en Corse du Sud. First international Workshop on *Posidonia oceanica* Beds, Boudouresque CF., Jeudy de Grissac A. et Olivier J. édit., GIS Posidonie publ., 193-201.

MEINESZ A., CAYE G., LOQUES F. and H. MOLENAAR, 1991. Growth and development in culture of orthotropic rhizomes of *Posidonia oceanica*. *Aquatic bot.* 39 : 367-377.

PERGENT G., 1985. Floraison des herbiers à *Posidonia oceanica* dans la région d'Izmir (Turquie). *Posidonia Newsletter* (1) 1 : 15-21.

PERGENT G. 1987. Recherches lépidochronologiques chez *Posidonia oceanica* (Potamogétonaceae). Thèse Univ. Aix-Marseille II : 853p.

B

B

AN ESSAY OF THE USE OF THE HABITAT EVALUATION PROCEDURE IN THE PLANNING OF A MARINE RESERVE (PELAGIAN ISLANDS, SOUTH MEDITERRANEAN)

Renato CHEMELLO and Silvano RIGGIO

Istituto di Zoologia dell'Università di Palermo, via Archirafi, 18. 90123 Palermo, Italia

The Pelagian archipelago includes 2 major islands : Linosa, further north, Lampedusa, about 30 mls south, with the rock of Lampione. The former is an extinct volcano, made up of recent olivinic and feldspathic basalts rising on a platform of eruptive debris; the latter isles are a calcareous protrusion of the African shelf; their substrata are a mixture of holocoenic sandstone and miocoenic dolomitic rocks. The good state of their coastal environment and the high landscape diversity makes the Pelagian islands an appreciated touristic resort and a major biological reserve as well. The need for a conservative management of the coastal system has boosted a comprehensive bionomic survey (CHEMELLO and DI GERONIMO, 1992), whose results are still under examination. The perspective of setting up a marine reserve has led us to apply to the Pelagian biotopes some of the most advanced methods used to assess the value of terrestrial areas. A major drawback has been to find marine biological indicators corresponding to the terrestrial ones; the rarity of endemic and/or significant taxa has made our task particularly difficult. Therefore we have adjusted the available information in order to fit the main guidelines of the U.S. Fish & Wildlife Service and worked out the data according to a modified version of the H.E.P. (Habitat Evaluation Procedures) applied to the conservation of marine coastal areas (CHEMELLO, 1991). Methods and results are summarily reported in the following text : three different scales of indicators of ecological interest have been chosen, values have been assigned to single areas, and the results have been combined to obtain a comprehensive coefficient of the importance of each biotope and/or community. The Mollusc syntaxon has been used as basic descriptor. Twelve major environmental units (EU) have been identified, each encompassing a homogeneous coastal section, suited for one sampling and two bionomic transects, statistically representative of the biotic systems. The following parameters have been chosen: extension (EX); environmental health (EH); anthropic interest (AI); protection of terrestrial systems (SP); environmental diversity (ED). From paired comparison of the main values, the most important criteria have been referred to as : EH, SP, ED. Criteria and relative weights (RW) assigned to each EU have been arranged in a matrix, where numbers were respectively 0.1, 0.5, 1.0. Relative values (UVR) of EUs have been obtained by multiplying the value of each EU by the RW assigned to the single criteria. The actual value (HRV) calculated for each EU has been obtained by the UVR/MUVR (= maximum recorded UVR) ratio. The highest numbers have characterized the 11th and 12th sector of Linosa as well as the 4th sector of Lampedusa, whereas the lowest HRVs have been recorded in in the 1st, 2nd and 8th sectors of the same island. The following 7 criteria have been selected for the calculation of the naturalistic, scientific, and recreational index (NSRV): naturality (NA), aesthetics (AE), biotic diversity (BD), water quality (WQ), naturalistic (NI), economic (EI) and recreational interest (RI) : NA, EI and AE have been identified as highly significant. The 12 EUs have been ordered in a matrix using the same procedure as above. The 7th, 2nd and 1st sectors of Lampedusa have shown, in the order, the highest values, especially referred to BD. From cross comparison of the HRVs and NSRVs a scale of importance of the coastal sectors has been created : the 11th and 12th sectors of Linosa and the 7th sector of Lampedusa have ranged in the top three.

A list of significant biotopes has then been made, using the following selective criteria : extension (ET), resilience (RE), diversity according to Shannon (DH); early sensitivity (ES), that is, the ability to respond quickly to habitat alterations; easiness of control (CE), expressing the availability of monitoring facilities; anthropic importance (AT), related to educational and economic fruition; autochthonicity (AH), quantification of the importance of endemic or rare organisms. DH, ET and CE have appeared most suited to our survey; RE and ES have been of less use. The following parameters have been chosen to calculate the sensitivity index (SI): resilience (RL), species richness (SR), biotic diversity (BD), species rarity (SY), size criticity (SC), functional specificity (FS), specific sensitivity (SS), generic sensitivity (GS). BD has been confirmed as the most signficant sensitivity criterion, followed by SS, FS, SC, GS. Use of SI has stressed the primary role of the Posidonia oceanica meadow, followed by the photophilous infralittoral settlements and the fringe communities. Our results have enabled us to identify and assign importance values to the areas more worth conservation, and therefore put forward an overall plan of the forthcoming reserve, as illustrated in Fig. 1.

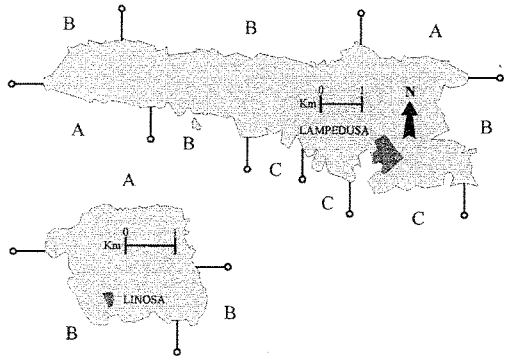


Fig. 1: the Islands Lampedusa and Linosa, with location of zones A, B and C, suggested by HEP.

REFERENCES

CHEMELLO R., 1991. Contributo alla cartografia biocenotica dei fondali delle Isole Pelagie e struttura del popolamento a Molluschi ai fini della costituzione della Riserva marina. Doctorate of Research Thesis, University of Messina, 235 pp.

CHEMELLO R. and S. Di GERONIMO, 1992. Primi dati sulla malacofauna marina bentonica delle Isole Pelagie (AG) nell'ambito degli studi di fattibilità della Riserva marina. *Oebalia*, suppl. XVI I: 479-484.

LINKS BETWEEN SEDIMENT POLLUTION AND *CAULERPA TAXIFOLIA* PROLIFERATION

J. R. M. CHISHOLM[1], F. FERNEX[2], D. MATHIEU[2] and J. M. JAUBERT[1]

[1] Observatoire Océanologique Européen (OOE), Centre Scientifique de Monaco (CSM), avenue Saint-Martin, MC 98000, Monaco

[2] Laboratoire de Géochimie Isotopique, Université de Nice - Sophia Antipolis, Parc Valrose, 06108 Nice Cedex 2, France

Under laboratory conditions, the productivity of free-living Mediterranean samples of *Caulerpa taxifolia* (Vahl) C. Agardh is unremarkable. Winter-acclimated specimens exhibit rates of net photosynthesis that fall well within the range of all reported productivity estimates for other species within the genus throughout the normal range of seawater temperatures encountered annually on the Côte d'Azur (GAYOL *et al.*, in press). Similarly, the growth rate of *C. taxifolia* is slow when samples are cultured in aquaria on beds of nutrient-free, glass beads (ca 2 mm diam.; unpubl. data). Typically, resources are directed toward stolon and rhizoid production rather than frond growth. These observations indicate that substrate chemistry may significantly influence the growth of *C. taxifolia* in the field.

During August and September 1994, we analysed a suite of biogeochemical properties of the interstitial waters of sediments removed from within: 1) the *C. taxifolia* population existing below the Musée Océanographique de Monaco; 2) a dense meadow of *Posidonia oceanica* in the Larvotto Reserve; 3) a mixed population of both species at Cap Martin; and 4) a mixed population of both species between the port of Fontvielle and Cap d'Ail.

Remarkable differences were observed in ammonium potentiality and production between the first two and the last two sites. At Cap Martin (3) and near Cap d'Ail (4), environments which now support vigorously growing populations of *C. taxifolia*, the microbial capacity of sediment interstitial waters to reduce a variety of added organic nitrogen substrates and generate ammonia was feeble. In contrast, actual ammonium production within sediment interstitial waters was much higher at sites 3) and 4) than at sites 1) and 2). These data indicate large supply rates of bacteria-laden organic material to the seabed at Cap Martin and near Cap d'Ail but almost no microbial activity within the sediment itself for subsequent transformation of organic nitrogen. These microbial contra-indicators are typical of sediments polluted by waste-water discharges.

Sediment interstitial water parameters below the Musée and in the Larvotto Reserve were for the most part comparable. It may be significant that photographic records now demonstrate a reduction in *C. taxifolia* abundance below the Musée. An optimistic view may be that ten years of vigorous *C. taxifolia* growth in this environment has had a remedial effect on sediment quality.

We tentatively conclude that anthropogenic pollution probably first causes degeneration of *P. oceanica* meadows. The resulting base of dead organic material, together with continuing inputs of human waste from sewage outfalls then creates a resource for *C. taxifolia* which appears better able to survive in polluted environments. Fluorescence and scanning electron microscopy confirms the presence of large numbers of bacteria living in association with the surface of the subterranean rhizoids. Preliminary measurements indicate that these populations are supplied with oxygen during photosynthesis thus facilitating aerobic microbial nutrient cycling, a process that would have obvious advantages in anaerobic sediments. Enhanced bacterial degradation of organic material and possibly also direct uptake of organic substances by *C. taxifolia* itself would serve to promote the remediation of polluted sedimentary environments.

RÉFÉRENCES

GAYOL, P., C. FALCONETTI, J. R. M. CHISHOLM and J. M. JAUBERT, in press. Metabolic responses of low-temperature-acclimated *Caulerpa taxifolia* (Chlorophyceae) to rapidly elevated temperature. *Bot. Mar.*

DEUX ASPECTS SAISONNIERS DU PHYTOBENTHOS DANS LE GOLFE DE MALIAKOS (MER EGÉE, GRÈCE)

CHRYSSOVERGIS F. et PANAYOTIDIS P.

Centre National des Recherches de la Mer, 16604 Agios Kosmas, Athènes, Grèce

Le golfe Maliakos situé à la limite du secteur septentrional et du secteur central de la Méditerranée orientale (PERÈS et PICARD, 1964) présente un grand intêret écologique et phytogéographique. Cinq stations (A, B, C, D, E) ont été choisies sur un gradient d'eutrophisation partant de l'embouchure de la rivière Sperchios (Station A dans le golfe Maliakos) vers la mer Egée (Station E). Dans chaque station, deux séries de prélèvements saisonniers (hiver - été) ont été effectuées sur des quadrats de 20 cm x 20 cm. Dans chaque prélèvement, nous avons effectué une analyse qualitative et quantitative du phytobenthos (BOUDOURESQUE, 1971).

Le spectre floristique du phytobenthos comporte 186 espèces dont 98 Rhodophycées, 40 Phaeophycées, 31 Bryopsidophycées et 16 Chlorophycées. Le nombre d'espèces par relevé varie de 8 à 49 (avec un nombre moyen de 32). Le golfe Maliakos donc semble être plus riche en espèces que le golfe Thermaikos situé dans la partie septentrionale de la mer Egée avec 121 espèces citées et 12 à 31 espèces par relevé (HARITONIDIS, 1978) mais moins riche que l'île de Milos située dans la partie sud de la mer Egée avec 190 espèces citées et 28 à 107 espèces par relevé (LAZARIDOU, 1993).

Les résultats de notre étude sont présentés sommairement sous forme de tableaux des valeurs de la Dominance Qualitative DQ , de la Dominance Quantitative DR et de la Tension Ψ des prélèvements hivernal et estival.

En ce qui concerne la DQ, on remarque une diminution caractéristique des valeurs des Chlorophycées au fur et à mesure qu'on s'éloigne de la source de nuisance. Les valeurs de la DQ des Phaeophycées, au contraire, présentent un accroissement qui suit le gradient.

La DR des Chlorophycées ainsi que des Bryopsidophycées montre des valeurs très hautes (hiver comme été) aux stations A et B dues à la présence des espèces caractéristiques de pollution comme *Ulva lactuca* et *Ulva rigida*. La DR des Phaeophycées augmente beaucoup aux stations C, D et E. Les valeurs très hautes de la DR sont dues à la présence de différentes espèces du genre *Cystoseira* qui est la caractéristique de la phytocénose de l'infralittoral supérieur.

La Tension des Chlorophycées est >1 en hiver aux stations A et B fait qui signifie que les Chlorophycées sont bien adaptés dans ce biotope. La Tension des Phaeophycées est >1 pendant toute l'année à toutes les stations et augmente aux stations C, D et E. La Tension des Rhodophycées est >1 seulement aux stations A et B pendant l'été.

PRELEVEMENT HIVERNAL

	A	B	C	D	E
DQ% CHLOROPHYCEAE	22.47	24.77	14.66	6.95	9.11
DQ% BRYOPSIDOPHYCEAE	12.58	17.59	7.44	13.69	14.73
DQ% PHAEOPHYCEAE	14.29	9.72	25.85	26.15	20.54
DQ% RHODOPHYCEAE	50.66	47.92	52.05	53.22	55.62
DR% CHLOROPHYCEAE	29.82	56.10	2.34	0.10	0.58
DR% BRYOPSIDOPHYCEAE	4.47	11.37	1.08	4.85	5.51
DR% PHAEOPHYCEAE	21.89	11.89	80.14	70.32	64.34
DR% RHODOPHYCEAE	43.82	20.63	16.44	24.73	29.57
Ψ CHLOROPHYCEAE	1.33	2.30	0.16	0.01	0.06
Ψ BRYOPSIDOPHYCEAE	0.38	0.63	0.14	0.36	0.38
Ψ PHAEOPHYCEAE	1.52	1.33	3.13	2.71	3.21
Ψ RHODOPHYCEAE	0.87	0.43	0.32	0.46	0.53

PRELEVEMENT ESTIVAL

	A	B	C	D	E
DQ% CHLOROPHYCEAE	19.24	10.23	13.86	12.21	9.26
DQ% BRYOPSIDOPHYCEAE	12.16	22.73	7.85	12.33	13.79
DQ% PHAEOPHYCEAE	14.22	2.78	16.89	23.69	28.38
DQ% RHODOPHYCEAE	54.39	64.27	61.39	51.78	48.57
DR% CHLOROPHYCEAE	5.07	7.72	5.72	0.46	0.30
DR% BRYOPSIDOPHYCEAE	9.5	19.80	1.39	6.72	5.35
DR% PHAEOPHYCEAE	9.44	4.62	34.74	50.86	72.67
DR% RHODOPHYCEAE	75.99	67.86	58.15	41.96	21.68
Ψ CHLOROPHYCEAE	0.27	-	0.44	0.04	0.03
Ψ BRYOPSIDOPHYCEAE	0.91	0.90	0.13	0.54	0.39
Ψ PHAEOPHYCEAE	0.67	-	2.12	2.16	2.57
Ψ RHODOPHYCEAE	1.42	1.06	0.95	0.81	0.45

REFERENCES

BOUDOURESQUE C.F., 1971. Méthodes d'étude qualitative et quantitative du benthos (en particulier du phytobenthos). *Tethys*, 3 : 79-104

HARITONIDIS S., 1978. Contribution à l'étude des peuplements des macrophyceae benthiques (Chlorophyceae, Phaeophyceae et Rhodophyceae) du golfe Thermaikos. Thèse Doct., Univ. de Thessaloniki : 173 p.

LAZARIDOU E., 1993. Etude systématique, bionomique et écologique du phytobenthos marin de l'île de Milos (Cyclades). Thèse doct., Univ. de Thessaloniki : 274 p.

PERES J.M. et PICARD J., 1964. Nouveau manuel de bionomie benthique de la mer Méditerranée. *Rec. Trav. Stat. mar. Endoume*, 31 (47) : 5-137.

MORPHOTYPES DIFFERENTIATION AS AN ADAPTIVE STRATEGY : AN EXAMPLE IN A CORALLIGENOUS COMMUNITY

S. COCITO, M. MORGIGNI, S. SGORBINI

ENEA-CRAM, S. Teresa, CP 316, 19100 La Spezia, Italy

Studies of biodiversity, as the expression of complexity of a biological structure both at the community and species level (COGNETTI G. & CURINI-GALLETTI M., 1993), has received increasing interest in recent years. Among the hard bottom marine communities coralligenous formations *(sensu* PERES & PICARD, 1964) exhibit such a high degree of complexity and diversity as to be considered a polybiocenotic species assemblage (PICARD, 1985).

Investigations on zonation and morpho-functional aspects of coralligenous communities on a rocky shoal in the Ligurian Sea (COCITO *et al.*, 1994), showed the existence of peculiar environmental conditions, mainly hydrodynamics, which have yielded diversification in microbiotopes. Among surface-dependent organisms an array of growth forms was identified as adaptive structural fitness.

This study emphasizes the presence of two zoarial types for a bryozoan species (*Pentapora fascialis*, Pallas, 1766), clearly distinguished in shape, size, pattern of growth and distribution. Visual surveys and *in situ* measurements were carried out in the summer of 1991 by SCUBA diving along radial transects on the shoal.

The first typology (fig. 1) was exhibited by *Pentapora fascialis* zoaria, small in size and with slender branches giving a reticulate appearance; these were common in the shallower zone, near the top of the shoal (16 m deep) and almost absent on the channel cliffs. The second form, identified as *Pentapora fascialis* f. *foliacea*, was the predominant component of the benthos on the rocky, current swept bottoms (from 18 to 26 m), which in turn terminate close to the muddy bottom. The colonies, composed of thick, robust foliaceous laminae, were of spectacular size (Ø 82 cm max.).

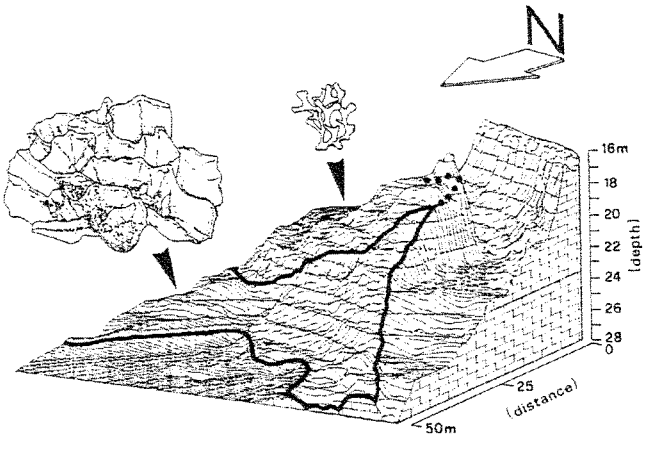


Fig. 1: Distribution of the two zoarial types.

Discussions as to whether the two types belong to different species (GAUTIER, 1962) or if they represent a case of ecotype (ZABALA, 1986) have already been dealt with. Traditional taxonomic procedure utilized to distinguish bryozoan species are not always exhaustive because of numerous modifications of skeletal properties taking place during growth of the colony.

In any case, morphological and ecological characteristics evidenced in the study area indicate the presence of two forms, whose trophic capacity strictly depends upon food capture surface (JACKSON, 1977), adapted to different environmental conditions.

We conclude that colony shape is affected as much by interaction with the biological environment, in particular food availability, as by physical causes that are in this case water movement and siltation. In these terms, morphological differentiation could be interpreted as an index of environmental diversity.

Although the study area represents a small scale biotope, it can be used to verify correlation between biological diversity and the flexibility of response to different environmental conditions.

REFERENCES

COCITO S., SGORBINI S. & BIANCHI C.N., (submitted). The suspension-feeder community of a temperate rocky shoal : zonation and morpho-functional aspects.

COGNETTI G. & CURINI-GALLETTI M., 1993. Biodiversity conservation problems in the marine environment. *Mar. Pollut. Bull.* 26 (4) : 179-183.

GAUTIER Y.V., 1962. Recherches écologiques sur les Bryozoaires Cheilostomes en Méditerranée occidentale. *Rec. Trav. Stat. mar. Endoume*, 38 (24) : 1-434.

HARMELIN J.G., 1975. Relations entre la forme zoariale et l'habitat chez les bryozoaires cyclostomes : conséquences taxonomiques. *Bryozoa* 1974. Docums lab. Géol. Fac. Sci. Lyon. 2 : 329-384.

JACKSON J.B.C., 1977. Competition on marine hard substrata : the adaptive significance of solitary and colonial strategies. *Am. Nat.*, 111 : 743-767.

PERES J. & PICARD J., 1964. Nouveau manuel de bionomie benthique de la mer Méditerranée. *Rec. Trav. Stat. mar. Endoume*, 31 (47) : 1-137.

PICARD J., 1985. Réflexions sur les écosystèmes marins benthiques : hiérarchisations, dynamique spatio-temporelle. *Téthys*, Fr., 11 (3-4): 230-242.

ZABALA M., 1986. Fauna dels Briozous dels Països Catalans. Inst. Est. Cat., Ed. Barcelona: 1-834.

B

FISH COMMUNITY ASSOCIATED WITH AN ARTIFICIAL REEF NORTH OF FORMENTERA ISLAND (WESTERN MEDITERRANEAN)

J. COLL, J. MORANTA, O. REÑONES and I. MORENO

Marine Biology Laboratory, Universitat de les Illes Balears 07071, Palma, Spain

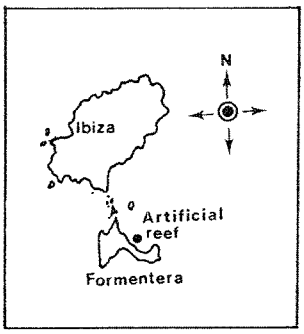
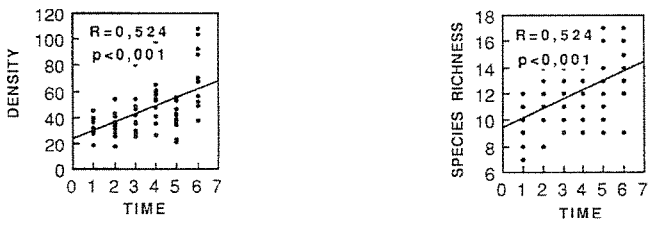


Fig.1. Situation of the artificial reef, north of Formentera island

An artificial reef moored in Playa de Tramontana, between Punta Prima and Recó des Caló, N of Formentera Island (Fig. 1.), situated in 38°41'75'N 01°30'00' E has been studied. The reef composed of 50 boulders of 8 m^3 is 30 m deep and occupies an aproximate area of 39.000 m^2. The fish community established in the reef after one year and its temporal evolution over the course of two years is given. The monitoring has been carried by visual census, using scuba dives, in February, May and September of 1992 and 1993. Nine to twelve previously marked boulders, located on *Posidonia oceanica* meadows, were sampled every time. The mean density for each species and the average values of the specific richness, diversity (Shannon-Weaver), total density and the density of categories 3, 4, 5 and 6 of HARMELIN (1987) have been calculated. In order to establish the temporal succession, the analyses of hierarchic classification and correspondence have been taken into account. The community descriptive indexes have been calculated by means of correlation analysis and ANOVA (SOKAL & ROLF, 1979). Thirty nine species have been counted (Table I), the most representative of which during the whole study have been: *C. chromis, C. julis, S. tinca, D. vulgaris, A. imberbis, S. mediterraneus, S. cabrilla, S. scriba, S. melanocercus, S. rostratus, L. viridis, L. merula, S. doderleini, S. scrofa, B. rouxi* and *M. helena*. The specific composition of the samples was very similar during the study period. However, the average number of species per boulder and the density of those belonging to categories 3, 4, 5, and 6 increased significantly from February 92 to the end of the study in September 93 (Figs. 2 and 3). Therefore, colonization by most of the caracteristics rocky bottom and *Posidonia* meadow species at 30 m had already taken place during the first year, but the frecuency around the boulders increasd with time.

	Febr. 92	May. 92	Sept. 92	Febr. 93	May. 93	Sept. 93
M. helena	0.33±0.24	0.17±0.11	0.15±0.10	0.15±0.10	0.17±0.17	0.09±0.09
E. caninus	-	-	-	0.08±0.08	0.08±0.08	0.09±0.09
E. alexandrinus	-	-	-	0.15±0.15	-	-
E. guaza	-	-	0.15±0.15	-	0.42±0.23	0.18±0.12
S. cabrilla	1.67±0.17	1.33±0.14	1.08±0.14	1.38±0.35	0.67±0.14	0.18±0.26
S. scriba	1.22±0.76	0.83±0.32	0 .46±0.18	1.31±0.55	2.33±0.48	1.45±0.59
A. imberbis	2.00±0.71	2.08±0.47	2.46±0.48	2.54±0.76	1.58±0.45	5.27±1.01
S. dumerili	12.9±8.28	-	-	-	54.2±42.4	10.5±7.40
S. umbra	0.11±0.11	0.25±0.13	0.54±0.31	0.15±0.10	0.33±0.14	1.27±0.79
M. surmuletus	-	-	0.31±0.17	0.31±0.17	-	0.45±0.37
D. annularis	0.11±0.11	0.67±0.22	0.69±0.24	0.31±0.13	0.71±0.11	1.55±0.78
D. puntazzo	-	-	0.31±0.13	0.31±0.24	0.25±0.13	0.45±0.37
D. sargus	-	-	0.31±0.31	0.38±0.24	0.75±0.43	3.00±1.47
D. vulgaris	1.78±0.72	2.17±0.58	3.46±1.54	8.31±3.39	2.50±1.64	2.45±1.60
S. cantharus	-	0.08±0.08	-	-	-	0.36±0.36
S. maena	-	-	-	11.6±11.5	6.33±6.24	1.82±1.82
S. smaris	-	-	-	3.15±2.08	-	3.64±3.64
C. chromis	73.4±12.0	64.8±13.4	88.3±15.2	110±11.44	106±28.37	59.0±10.5
C. julis	15.2±2.18	18.4±2.11	21.7±3.09	24.3±2.67	17.1±1.71	38.4±5.06
L. bimaculatus	-	0.08±0.08	-	-	-	-
L. merula	0.78±0.22	0.42±0.19	0.38±0.14	0.08±0.08	0.42±0.15	0.18±0.12
L. viridis	0.33±0.24	-	0.15±0.10	0.23±0.17	0.67±0.19	0.82±0.18
S. doderleini	0.11±0.11	0.50±0.19	0.77±0.17	0.38±0.14	0.33±0.14	0.55±0.28
S. mediterraneus	0.98±0.26	2.58±0.15	2.00±0.44	2.08±0.50	2.75±0.49	2.82±0.54
S. melanocercus	0.44±0.18	0.58±0.15	1.40.33	1.00±0.36	1.50±0.19	1.09±0.28
S. ocellatus	-	0.50±0.19	-	-	-	3.91±1.56
S. rostratus	0.33±0.17	0.58±0.19	0.31±0.13	1.15±0.67	1.08±0.36	0.27±0.19
S. tinca	6.44±2.16	2.92±0.61	1.31±0.35	7.69±1.73	3.25±0.48	2.09±0.59
T. pavo	-	-	-	-	-	0.09±0.09
G. auratus	-	-	0.31±0.21	-	0.08±0.08	-
G. cruentatus	-	0.08±0.08	-	0.08±0.08	-	-
G. geniporus	-	-	0.15±0.10	0.08±0.08	0.08±0.08	-
G. vittatus	-	-	0.31±0.31	-	0.17±0.17	-
Gobius sp.	0.89±0.89	-	-	-	-	0.09±0.09
B. rouxi	-	0.08±0.08	0.54±0.22	0.46±0.27	0.08±0.08	2.18±2.18
T. delaisi	-	0.25±0.18	0.38±0.21	-	0.83±0.27	1.55±0.51
Tripterigion sp.	-	-	0.46±0.24	0.23±0.17	0.67±0.26	-
S. porcus	-	-	-	0.08±0.08	-	-
S. notata	0.33±0.17	0.17±0.11	0.15±0.10	1.08±0.24	0.67±0.28	-

Table 1.Mean density and standar error per boulder for all species censused.



Figures 2 and 3. Corrrelation analysis between number of species (Fig. 2) and density of categories 3, 4, 5 and 6 (Fig. 3) and time (1 : February 92 to 6 : September 93).

REFERENCES

HARMELIN J.G., 1979 . *Marine Ecology*, 8(3) : 263-284

SOKAL R.R. & ROLF Fk.,1979. Biometría. 832 pp. Ed. Blume. Madrid.

PHENOLOGY OF A RECENT *POSIDONIA OCEANICA* SETTLEMENT IN THE LIGURIAN SEA, WESTERN MEDITERRANEAN

L. DAVICO and G. MATRICARDI

Istituto di Anatomia Comparata dell' Università di Genova, 16132 Genova, Italia

The litterature on *Posidonia oceanica* phenology is rich and reports data from different geographical areas and depths of the Mediterranean Sea (BOUDOURESQUE *et al.*, 1984; BOUDOURESQUE *et al.*, 1987). Information mainly concerns large meadows and is often related to regression problems. Few data are available on the phenology of a beginning settlement of the seagrass (COOPER, 1979; MEINESZ and LEFEVRE, 1984). So, on 1992, we began to collect data on the dimensions and on the phenology (shoot density, number of leaves per shoot, leaf length and width) of some little tuft of *Posidonia oceanica* settled on hard substrate, at 4 m depth, near Cogoleto (8°39' E, 44°24' N) in the Ligurian Sea. No traces of living or death meadow have been found all around the site. Local fishermen and SCUBA-divers, besides, agree in dating four or five years back the first observation of these settlements of the seagrass. Owing to the reduced size of the tufts (the largest is about 100 cm long and 70 cm wide), a not destructive procedure has been followed to collect data *in situ*, by SCUBA-diving, without sampling. All the dimensions have been measured in mm, by a soft rule, while densities have been calculated from a 400 cm^2 surface and leaf counts have been made by direct observation. By such a procedure, underestimates of phenological parameters are probable : leaf base are not considered, youngest leaves cannot easily be detected, etc. So, the reported results must be considered as a preliminary information about the development of these *Posidonia* tufts.

Mean shoot density (calculated inside the tufts) is very high : 1327.0 shoots/m^2 (s.d. 175.8). Although it is hard to compare this figure with the available information about large meadows settled in comparable environmental conditions, we can observe that the Prelo meadow (Portofino promontory : 9°13.6' E, 44°20.2' N; 4 m depth. Personal observations) is characterized by a mean density of 670.0 shoots/m^2 (s.d. 227.3) and that PESSANI *et al.* (1987) report for the Punta Garavano meadow (7°29' E, 43°45' N; 6 m depth) a density of 950 shoots/m^2. In the Cogoleto tufts, the mean leaf number per shoot is 4.6 (s.d. 0.3) and is quite different from that reported by PESSANI *et al.* (1987) (8.5 leaves per shoot); on the other hand, this figure is similar to that of the growing margin (plagiotropic axes dominant) of a large meadow 2.5 km far from the tufts : 4.4 leaves per shoot (s.d. 1.0). Leaves dimensions differ from those of other prairies: the mean leaf length of the tufts is 141.8 mm (base excluded) while the mean length measured in the margin of the Cogoleto large meadow is 202.9 mm (base excluded). Seasonal figures show a clear trend (fig.1): the highest mean length has been measured in June (215.0 mm), the lowest in November (95.0 mm). BUIA *et al.* (1992) report a similar trend for intermediate and adult leaves of a meadow at 5 m depth (Ischia island). The mean leaf width of the Cogoleto tufts is 7.8 mm (s.d. 0.9), while the Cogoleto meadow figure is 9.0 mm and the Punta Garavano figure (PESSANI *et al.*, 1987) is 8.9 mm. During cold season, the mean leaf width of the tufts is higher (8.1 mm in November; 7.8 mm in January), while in summer is lower (6.5 mm in july). Leaf area index (LAI) shows a seasonal trend related to the water temperature (fig.2): the lowest mean value has been observed in November (4.2 m^2/m^2), the highest in June (10.5 m^2/m^2); a summer decrease is evident. PESSANI *et al.* (1987) report a LAI of 15.8 m^2/m^2. Phenological features quite similar to those described in this work have been observed in a little tuft sampled on May 1994 in the Sori meadow (9°7' E, 44°23' N; 4 m depth), on hard substrate. In this site, the residuals of a largest meadow (deepest at present), scattered on hard substrate widely not covered by *Posidonia oceanica*, show phenological parameters quite different from the sampled tuft (data not published). The hypothesis that the Cogoleto and Sori tufts represent a recent settlement of *Posidonia oceanica* is supported, besides, by the growth observed at Cogoleto; single and randomly placed external rhizomes, marked at the base of the youngest scale, showed a 7.0 cm/year elongation during the experiment. More data are requested to confirm this hypothesis and to describe the phenology of *Posidonia oceanica* during substrate colonization.

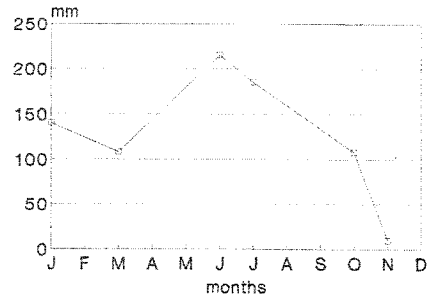


Fig. 1. Leaf length

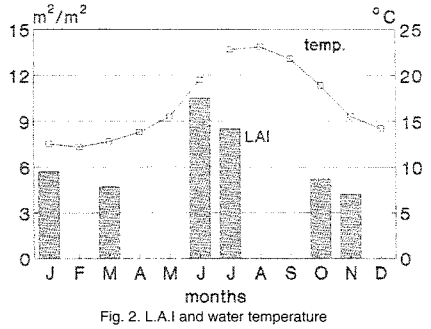


Fig. 2. L.A.I and water temperature

REFERENCES

BOUDOURESQUE C.F., JEUDY DE GRISSAC A. and OLIVIER J., 1984. I International Workshop on *Posidonia oceanica* beds. GIS Posidonie, Marseille: 454 pp.

BOUDOURESQUE C.F., MEINESZ A. and FRESI E., 1987. II International Workshop on *Posidonia oceanica* beds. GIS Posidonie, Marseille: 321 pp.

BUIA M.C., ZUPO V. and MAZZELLA L., 1992. Primary production and growth dynamics in *Posidonia oceanica*. *P.S.Z.N. I. Mar. Ecol.*, 13 (1) : 2-16.

COOPER G., 1979. *Posidonia oceanica*, un arbre. Association-Fondation G. Cooper. Jardinier de la Mer, 3 : 66 pp.

MEINESZ A. and LEFEVRE J.P., 1984. Régénération d'un herbier de *Posidonia oceanica* quarante années après sa destruction par un bombe dans la rade de Villefranche (Alpes Maritimes - France). I : I International Workshop on *Posidonia oceanica* beds, Boudouresque C.F., Jeudy de Grissac A. and Olivier J. (Eds.), GIS Posidonie, Marseille : 39-44.

PESSANI D., CALTAGIRONE A., PONCINI F. and VETERE M., 1987. Confronto tra due praterie di *Posidonia oceanica* della Riviera Ligure di Levante e di Ponente. 1. Descrizione e parametri fenologici. *Posidonia Newsletter*, 1 (2): 5-20.

ÉTUDES BIOMÉTRIQUES DE LA PALOURDE *RUDITAPES DECUSSATUS* (LINNÉ, 1758) DU LITTORAL TUNISIEN

EL-MENIF N.[1], LE-PENNEC M.[2], MAAMOURI F.[1]

[1] Laboratoire de Biologie Animale, Faculté des Sciences de Tunis, 1060 Tunisie
[2] Lab. de Biologie Marine, Univ.de Bretagne occidentale, 29287 Brest Cédex, France

Afin de caractériser les populations de palourdes de Tunisie et de les situer par rapport à d'autres populations méditerranéennes et atlantiques, nous avons réalisé une étude biométrique qui fournit des résultats sur la croissance relative des diverses proportions du corps et les changements qui peuvent affecter l'animal au cours de son développement. L'étude a été effectuée sur deux stations : celle de Gargour, sur le littoral du golfe de Gabès (Sud tunisien) et celle de Menzel-Jemil, sur la bordure est du lac de Bizerte (Nord tunisien). Dans chacune des stations, 360 individus ont été récoltés à raison de 30 spécimens par mois. Les prélèvements ont été réalisés de janvier à décembre 1992. Les mensurations ont été effectuées à l'aide d'un pied à coulisse gradué au 1/10 de mm et d'une balance de précision à 0,01 g près. Les différents paramètres retenus pour cette étude ont été :

- la longueur **L**, correspondant à la plus grande distance antéro-postérieure, parallèle à l'axe de la charnière,
- le poids frais total de chaque individu $\mathbf{W_{t\text{-}f}}$,
- le poids de la chair sèche, après séchage à l'étuve pendant 24 heures à 60°C, **Wch-s**,
- le poids des 2 valves débarrassées de la chair et étuvées jusqu'au poids constant : **Wcq.s.**

Nous avons établi pour les deux sites les équations générales liant la longueur antéro-postérieure au poids total frais, au poids de la chair sèche et au poids de la coquille sèche. Les résultats obtenus sont répertoriés dans le tableau 1 et illustrés graphiquement par les figures 1-2-3.

Relation	Station	Equations	r	x	Extr. x	y	Extr.y	sdx	sdy	Test t
L/Wt-f	G.	$W=1.9958\times10^{-5}L^{3.027}$	0.98	35.7	21 - 52.8	0.8	1.79-28.54	5.76	4.81	3.02
	M-j.	$W=1.317\times10^{-5}L^{3.078}$	0.98	32.2	16.5-47.1	0.3	0.75-17.68	5.36	3.13	12.73
L/Wch.s	G.	$W=1.5437\times10^{-6}L^{3.611}$	0.92	35.7	21 - 52.8	0.1	0.07- 1.43	5.76	0.21	209.21
	M-j.	$W=1.6531\times10^{-6}L^{3.560}$	0.95	32.2	16.5-47.1	0.3	0.033-1.24	5.36	0.17	302.64
L/Wcq.s	G.	$W=6.5874\times10^{-5}L^{3.108}$	0.97	35.7	21 - 52.8	4.8	0.86-15.55	5.76	2.47	19.32
	M-j.	$W=3.666\times10^{-5}L^{3.203}$	0.96	32.2	16.5-47.1	2.7	0.33 - 7.5	5.36	1.43	50.88

Tableau 1: Equations liant la longueur au poids total frais, au poids de la chair sèche et à celui de la coquille sèche. G: Gargour; M-j: Menzel-jemil; r: coefficient de corrélation; x et y: valeurs moyennes de la longueur et du poids; Extr. x et y: valeurs extrêmes de la longueur et du poids; sdx et sdy: écart type; Test t: test de Student.

Relation longueur-poids total frais. La valeur de r = 0,98 proche de l'unité montre l'étroite relation existante entre ces deux variables. Les valeurs de la pente et du test de Student nous permettent de déduire que l'allométrie est majorante dans les deux secteurs. La valeur du test de la pente : tpe = 1,044 < 1,96 montre que la croissance dans les deux sites est la même. Cependant, la valeur du test de la position : tpo = 14,26 > 1,96 indique que les individus de Gargour pèsent plus que ceux de Menzel-jemil quelle que soit la taille de l'individu. En comparant nos résultats à ceux fournis par GERARD (1978) et qui concernent des palourdes de Méditerranée (étang de Thau), de Bretagne (Kérity, Locmariaquer, Bindy, Moulin Mer, Douron), d'Irlande (Galway) , par GRAS et GRAS (1981) dans le bassin de Marenne-Oléron et par BREBER (1985) pour la lagune de Venise, nous constatons que la croissance relative du poids total frais est similaire entre le secteur Nord tunisien (Menzel-jemil) et la lagune de Venise. Pour la station de Gargour, les croissances se situent entre l'étang de Thau et celles des individus de ceux de la station de Locmariaquer.

Relation Longueur - Poids de la chair sèche. Les valeurs de r (tabl. 1) nous permet de déduire qu'il y a une très bonne corrélation entre ces deux variables. Les valeurs de la pente et du test de Student montrent que l'allométrie est minorante à Gargour et majorante à Menzel-jemil. En comparant la croissance intersites, nous constatons, d'après la valeur du tpe = 2,32, qu'il ya une différence significative en faveur des individus de Gargour jusqu'à la taille 42-43 mm. Au-delà, la différence est au profit des individus de Menzel-jemil.

Relation Longueur - Poids de la coquille sèche. Les valeurs de r proche de 1 montrent la bonne corrélation entre la longueur et le poids sec de la coquille . Les valeurs de la pente, supérieures à 3, dans les deux stations indiquent une allométrie majorante. Le test t montre que l'augmentation du poids sec de la coquille est significativement supérieure à celle de la longueur à Gargour, mais hautement significative à Menzel-jemil. La valeur du tpe = 1,53 nous permet de déduire que la croissance relative de la coquille est la même dans les deux secteurs et que la différence n'est significative qu'au niveau de la position tpo = 20,26. En effet, les individus de Gargour ont une coquille plus lourde que celle de Menzel-jemil, quelle que soit la taille de la palourde.

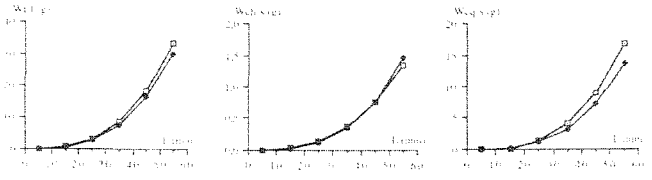


Figure 1-2-3: Relation entre la longueur et le poids frais total, le poids de la chair sèche et le poids de la coquille sèche dans les stations de Gargour et de Menzel-jemil. (: Gargour ; ■ : Menzel-jemil).

L'étude de l'évolution relative du poids a révélé que la croissance du $W_{t\text{-}f}$. $W_{cq\text{-}s}$ est supérieure à Gargour par rapport à Menzel-jemil. S'agissant du Wch-s, la croissance relative demeure meilleure jusqu'à la taille 42-43mm. Ces constatations nous permettent de déduire que les conditions de milieu du site Sud sont plus favorables pour la croissance de la palourde que celles du second site. En se plaçant donc du point de vue économique, les palourdes de Gargour sont généralement les plus avantageuses pour l'acheteur, car la dureté et l'épaisseur de la coquille réduisent le taux de casse au cours du transport. Pour le consommateur, la palourde de Gargour est plus intéressante si la taille est inférieure à 42-43mm. Au-delà, la palourde de Menzel-jemil devient intéressante étant donné que pour une même longueur, son pourcentage de chair est plus élevé.

REFERENCES

BREBER P., 1980. Annual gonadal cycle in the carpet-shell clam *Venerupis decussata* in Venice Lagoon, Italy. Proceedings of the National Shellfisheries Association,volume 70 : 31-35.

GERARD A., 1978. Recherches sur la variabilité de diverses populations de *Ruditapes decussatus* et *Ruditapes philippinarum* (Veneridae). Thèse 3ème cycle, C.O.B : 1-149.

GRAS M.P.ET GRAS P.,1981. Aquaculture de bivalves marins en claires dans le bassin de Marenne-Oléron; Nantes Science et pêche n 314, 30 p.

ÉTUDE DU CYCLE REPRODUCTEUR DE LA PALOURDE *RUDITAPES DECUSSATUS* (LINNÉ, 1758) DANS LA RÉGION DU GOLFE DE GABÈS (TUNISIE)

EL-MENIF N.[1], LE-PENNEC M.[2] , MAAMOURI F.[1]

[1] Laboratoire de Biologie Animale, Faculté des Sciences de Tunis, 1060 Tunisie
[2] Lab. de Biologie Marine, Univ. de Bretagne Occidentale, 29287 Brest Cédex, France

La palourde *Ruditapes decussatus*, mollusque bivalve, gonochorique, vit enfouie dans le sédiment. On la rencontre sur tout le littoral tunisien, au niveau médio et infra-littoral, notamment dans le Nord et surtout dans le Sud (Golfe de Gabès). L'exploitation exagérée de cette espèce, très demandée sur le marché international, a provoqué un appauvrissement du milieu naturel qui a enregistré, depuis 1982, une diminution progressive de la production. Cette situation préoccupante nous a incité à étudier le cycle reproducteur de cette espèce, première étape dans l'acquisition des bases biologiques nécessaires au démarrage de l'aquaculture. A terme, l'objectif est de produire du naissain destiné, en partie, au repeuplement du milieu naturel. Chaque mois d'octobre 1990 à décembre 1991, un échantillonnage de 20 individus a été effectué à la station de Gargour (côte nord du golfe de Gabès). Ces prélèvements nous ont servi, d'une part, à la détermination après biopsie du stade d'évolution de la gonade établi selon l'échelle de LUCAS (1965) : Stade A; B; C: Ca - Cb et, d'autre part, à l'étude histologique de la gonade. Dans ce cas, nous avons utilisé l'échelle de maturation établie par LUBET (1959): Stade 0; I; II; III; IIIA1; IIIA2; IIIB; IIIC; IIID. A partir de janvier 1992, nous avons poursuivi nos prélèvements à la même station et à raison de 30 individus par mois en vue de calculer l'indice de condition. L'indice retenu était celui de WALN et de MANN (1975) qui s'écrit :

$$IC = \frac{Wch\text{-}s}{Wcq\text{-}s} \times 103$$

Le poids sec des échantillons a été évalué aprés séchage à l'étuve à la température de 60°C jusqu'au poids constant de la chair et des valves déposées sur papier aluminium. L'étude histologique des gonades de la population de Gargour nous a permis de déduire que la palourde de cette région est bradyctique (à cycle étalé). En effet, il n'existe pratiquement pas de repos sexuel de la gonade qui reste en activité durant toute l'année. Mais le degré d'activité varie selon la saison. Cependant en janvier et février, 15% des individus observés ont une gonade vide. Celle-ci montre une forte activité de mars à décembre chez les mâles et de début mai à fin décembre chez les femelles. L'émission gamétique s'étale durant cette période, avec deux émissions privilégiées qui se situent respectivement de fin mai à début juin et de fin septembre à début novembre.

Quant aux variations de l'indice de condition, nous remarquons la présence de deux périodes de décroissances des valeurs (fig.1). Une, la plus étalée, se situe de juin à novembre durant laquelle les valeurs descendent progressivement avec des montées de faible amplitude pouvant traduire une restauration gonadique. Les valeurs de l'indice de condition sont minimales en novembre. Par la suite, on assiste à un accroissement de l'indice de 10% par rapport aux valeurs minimales pour chuter de nouveau en janvier. En février, on observe une légère remontée de l'indice qui rechute en avril. Durant cette période, il y a vraisemblablement eu ponte, suite à une restauration gonadique qui s'est déroulée dans la deuxième quinzaine de mars.

En comparant les variations de l'indice de condition entre mâles et femelles (fig.2), nous pouvons déduire que mâles et femelles se comportent de la même façon en mars, avril, mai et juin. A partir de juillet, nous assistons chez les femelles à une restauration gonadique suivie d'émissions gamétiques qui se répètent périodiquement jusqu'en décembre. Chez les mâles, l'émission gamétique se produit de juin à septembre. Par la suite, on assiste à une restauration gonadique qui s'étend jusqu'en décembre.

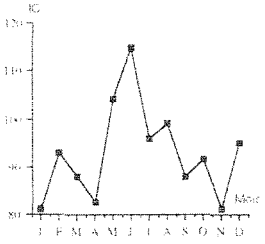


Figure 1 : Variation de l'indice de condition en fonction du temps dans la station de Gargour (Sexes confondus)

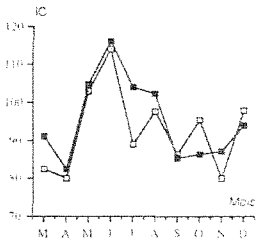


Figure 2 : Variation de l'indice de condition en fonction du temps dans la station de Gargour (■ : Mâle ; ● : Femelle).

Les résultats obtenus par l'étude histologique se rapprochent de ceux fournis par SARASQUETTE *et al.* (1990) qui ont travaillé sur la palourde japonaise *Ruditapes philippinarum* provenant de claires situées dans les marais salants de Cadix (Espagne). Par contre, la période de reproduction enregistrée pour les populations plus nordiques de *R. decussatus* est nettement plus courte (GALLOIS, 1977; GERARD, 1978; BREBER, 1980; LE PENNEC, 1981; BENINGER et LUCAS 1984). Bien que l'étude histologique et le calcul de l'indice de condition n'aient pas été traités la même année, nous pouvons dire que nous avons trouvé des résultats pratiquement identiques pour la période allant de mars à décembre. Par ailleurs, les résultats obtenus à partir de l'étude histologique en janvier et février ont montré l'absence de gamètes, alors que la valeur de l'indice de condition calculé a révélé une légère accumulation de matière organique en février.

REFERENCES

BENINGER P. G et LUCAS A. 1984. Seasonal variations in condition reproductive activity, and gross biochemical composition of two species of adult clam reared in a common habitat : *Tapes decussatus* L.(Jeffreys) and *Tapes philippinarum* (Adams et Reeve). *J. Exp. Mar. Biol. Ecol.*, 79 : 19-37.

BREBER P., 1980. Annual gonadal cycle in the carpet-shell clam *Venerupis decussata* in Venice Lagoon, Italy. Proceedings of the National Shellfisheries Association , Vol. 70 : 31-35.

GALLOIS D., 1977. Sur la reproduction des palourdes *Venerupis decussatus* (Linné) et *Venerupis aurea* (Gmelin) de l'Etang de Thau. *Vie et milieu*, 27(2) : 233-245.

GERARD A., 1978. Recherches sur la variabilité de diverses populations de *Ruditapes decussatus* et *Ruditapes philippinarum* (Veneridae). Thèse 3e cycle, C.O.B; 149 p.

LE PENNEC M., 1981. Les méthodes expérimentales induisant la ponte chez les mollusques bivalves marins. *Haliotis*, 11 : 139-155.

LUBET P., 1959. Recherches sur le cycle et l'émission des gamètes chez les pectinidés et les mytilidés. *Rev. Trav. I.S.T.P.M.*, Paris, 23 (4) : 396-545.

LUCAS A., 1965. Recherche sur la sexualité des mollusques bivalves. Thèse, Doc. Sci. Nat., Univ. Rennes, 135p.

SARASQUETE M.C.; GIMENO S. et GONZALEZ DE CANALES M.L., 1990. Cycle reproducteur de la palourde *Ruditapes philippinarum* (Adams et Reeve, 1850) de la côte sud-ouest atlantique (Espagne). *Rev. Int. Océanogr. Médit.* Tome LXXXXVII-LXXXXVII : 90-99.

WALN PR; MANN R.,1975. Growth and biochemical composition in *Ostrea edulis* and *Crassostrea gigas*. Proc. 9th Europ. Mar. Biol. Symp : 587-607.

B

B

EFFET DE *CAULERPA TAXIFOLIA* SUR LA PRODUCTIVITÉ DE DEUX MACROPHYTES MÉDITERRANÉENNES

E. FERRER, A. GOMEZ GARRETA & M.A. RIBERA

Unitat de Botanica, Fac. de Farmacia. Univ. de Barcelona. Barcelona, Spain

L'expansion de l'algue introduite *Caulerpa taxifolia* (Vahl.) C. Agardh en Méditerranée (MEINESZ & HESSE, 1991) a provoqué, dans la zone colonisée, un appauvrissement important de la flore algale autochtone (BOUDOURESQUE *et al.*, 1992). Les individus méditerranéens de *C. taxifolia* présentent un développement remarquable et donnent lieu à des prairies étendues qui peuvent se développer sur toutes sortes de substrats (BOUDOURESQUE *et al.*, 1992). Il semble exister une forte compétition entre cette algue et les autres espèces phytobenthiques, notamment pour la lumière. Il est difficile, pour l'instant, de savoir quels autres facteurs peuvent entrer en action. La plupart des algues de l'ordre des Caulerpales synthétisent des composés terpénoïdes à propiétés toxiques (PAUL & FENICAL, 1986). La libération de ces toxines dans l'eau pourrait avoir un effet sur certains organismes marins. Le sujet de ce travail est de démontrer si, en plus de la compétition pour l'espace et la lumière, il existe une action chimique de *C. taxifolia* sur le phytobenthos méditerranéen. Les expériences ont été réalisées, saisonnièrement, de novembre 1993 à août 1994. Les échantillons de *C. taxifolia* ont été récoltés au Cap Martin (France), à 10 m de profondeur. Les taxons de la flore locale testés ont été *Cystoseira barbata* (Goodenough et Woodward), C. Agardh f. *aurantia* (Kützing) Giaccone et *Gracilaria bursa-pastoris* (Gmelin) Silva, provenant de la Baie de Els Alfacs (Delta de l'Ebre, Espagne). Pour chaque taxon, on a fait une culture monospécifique, utilisée comme témoin, et une culture mixte, c'est-à-dire avec *C. taxifolia*, dans des aquariums de 40 l de capacité. Un système de tubes fluorescents de lumière blanche et froide a permis d'obtenir une irradiance, au niveau des plantes, de l'ordre de 150 µE m^{-2} s^{-1}. La température de l'eau a été réglée sur 16, 13, 18 et 25°C, en automne, hiver, printemps et été respectivement, et la photopériode a été de 12:12. Vingt-quatre heures après l'installation des cultures ont commencé les mesures de la production d'oxygène des plantes, par le système d'incubation en bouteille (LITTLER, 1979). La durée de chaque expérience a été de 15 jours environ. Pour chaque aquarium ont été réalisées 5 incubations de fragments de 0,2 g de poids frais dans des bouteilles de 250 ml disposées sur des plaques magnétiques et sous une irradiance de 300 µE m^{-2} s^{-1}. On a obtenu des courbes de production nette exprimées en mgC gPS^{-1} h^{-1}. Le traitement statistique correspond à une Anova et un test t de Student, avec un intervalle de confiance supérieur à 95%. Au prinptemps et en été, la production nette des exemplaires de *C. barbata* f. *aurantia* mis en contact avec *C. taxifolia* est significativement inférieure (< 0,05) à celle des individus de cultures monospécifiques, avec une plus grande différence pendant l'été. En automne, l'effet de *C. taxifolia* sur ce taxon se traduit très irrégulièrement et seulement entre le premier et le troisième jour de l'expérience. En hiver, aucun effet n'est détecté (Fig. 1). La résistance de *G. bursa-pastoris* à une éventuelle toxicité de *C. taxifolia* semble effective durant toute l'année. La productivité des exemplaires des deux cultures n'a pas présenté des différences significatives. Pendant l'été, une augmentation de la productivité des exemplaires de la culture mixte a même été observée. Les différences détectées sur les échantillons de l'hiver sont vraisemblement dues à l'hétérogénéité morphologique des fragments. (Fig. 2) L'action chimique de *C. taxifolia* sur *C. barbata* f. *aurantia* paraît évidente. L'effet se fait plus fortement sentir au printemps et en été, plus faiblement en automne. Ces résultats ne s'accordent que partiellement avec ceux de LEMÉE *et al.* (1993) qui estiment que les maximums de toxicité s'observent en été et en automne. L'absence, par contre, d'effet chimique sur *G. bursa-pastoris* pourrait indiquer que certains groupes de macrophytes marins possèdent des mécanismes de résistance.

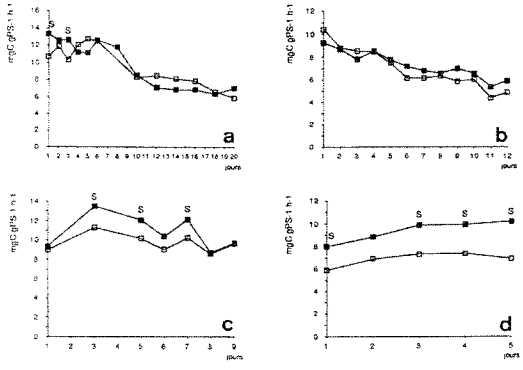


Fig. 1.- Courbes de productivité de *C. barbata* f. *aurantia* sans (■) et avec *C. taxifolia* (□) en (a) automne, (b) hiver, (c) printemps et (d) été. S = différences significatives entre moyennes.

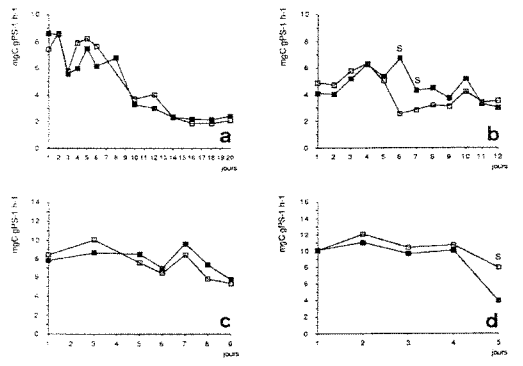


Fig. 2.- Courbes de productivité de *Gracilaria bursa-pastoris* sans (■) et avec *C. taxifolia* (□) en (a) automne, (b) hiver, (c) printemps et (d) été. S = différences significatives entre moyennes.

REFERENCES

BOUDOURESQUE C.F. *et al.*, 1992. *Cryptogamie-Algologie*, 13 (2): 144-145.
MEINESZ A. & HESSE B., 1991. *Oceanol. Acta*, 14 (4) : 415-426.
LEMÉE R. *et al.*, 1993. *Journal of Applied Phycology*, 5 : 485-493.
LITTLER M.M., 1979. *Aquatic Botany*, 7 : 21-34.
PAUL V.J. & FENICAL W., 1986. *Marine Ecology Progress Ser.*, 34 : 157.

EFFET DES EXTRAITS DE *CAULERPA TAXIFOLIA* (VAHL.) C. AGARDH SUR DEUX MACROPHYTES MÉDITERRANÉENNES

E. FERRER, M.A. RIBERA & A. GOMEZ GARRETA

Unitat de Botanica, Fac. de Farmacia. Univ. de Barcelona. Barcelona, Spain

Dans le cadre de l'étude de la toxicité de *Caulerpa taxifolia* sur les organismes marins de la Méditerranée (Programme CEE Life), l'effet possible des extraits méthanoliques de cette espèce a été testé sur deux macroalgues abondantes dans la Baie des Alfacs (Delta de l'Ebre, Espagne) : *Cystoseira barbata* (Goodenough et Woodward) C. Agardh f. *aurantia* (Kützing) Giaccone et *Gracilaria bursa-pastoris* (Gmelin) Silva. Ces extraits contiennent des métabolites secondaires toxiques tels que la caulerpénine, la caulerpécine et la caulerpine entre autres (DINI *et al.*, 1992; DOTY & AGUILAR- SANTOS, 1966; PAUL & FENICAL, 1986).

Les extraits ont été obtenus par R. Lemée (Université de Nice-Sophia Antipolis) à partir d'échantillons du Cap Martin (Alpes-Maritimes, France), récoltés à 10 m de profondeur en février, mai et août. Toute la plante (frondes, stolons et rhizoïdes) est introduite dans une solution méthanolique, laquelle, une fois filtrée, est soumise à un processus de séchage sous vide pour la récupérer postérieurement à l'éthanol (LEMÉE, *et al.*, 1993). La solution obtenue est maintenue à - 40°C jusqu'au moment où elle est utilisée au laboratoire. On dispose, pour chaque espèce, des cultures à différentes concentrations d'extrait (15, 30, 62, 125, 250 et 500 Mg d'extrait/ ml d'eau, plus 1, 5 et 10 Mg/ml en été). Puisque l'extrait méthanolique est peu soluble dans l'eau, les dilutions ont été faites avec l'éthanol. Pour chaque espèce, on dispose aussi de deux cultures témoin : sans et avec éthanol (à la plus haute concentration utilisée dans les dilutions). Les expériences ont été réalisées sous une irradiance moyenne de 150 µE m^{-2} s^{-1}, une photopériode de 12:12 et une température de 13, 18 et 25°C (en hiver, printemps et été, respectivement). La production d'oxygène a été mesurée par la méthode proposée par LITTLER (1979). Le traitement statistique des donnés correspond à un test t de Student (∞ < 0,05).

D'une façon générale, on peut affirmer que *C. barbata* f. *aurantia* est un taxon plus sensible aux extraits méthanoliques que *G. bursa-pastoris*, ce qui coïncide avec les résultats de l'étude de l'effet de *C. taxifolia* sur ces mêmes taxons (FERRER *et al.* 1995). En hiver, la productivité de *C. barbata* f. *aurantia* a diminué significativement à partir d'une concentration de 30 µg/ml, mais on ne connait pas la concentration exacte à partir de laquelle l'effet est perceptible (seuil). Pour *G. bursa-pastoris*, la réponse apparaît à partir de 250 µg/ml (Fig. 1). Au printemps, la production nette en oxygène des exemplaires de *C. barbata* f. *aurantia* a diminué, après 24 heures, à partir de concentrations de 15 µg/ml, tandis que *G. bursa-pastoris* a baissé sa production à partir de 125 µg/ml (Fig. 2). En été, la diminution du taux photosynthétique apparaît déjà à la concentration de 1µg/ml pour *C. barbata* f. *aurantia* et de 15 µg/ml pour *G. bursa-pastoris*; à des concentrations supérieures, les différences sont beaucoup plus importantes qu'aux autres périodes de l'année (Fig.3). L'effet de l'extrait cesse d'être significatif après une période comprise entre 48 et 52 heures, bien qu'à concentrations élevées (250 et 500 µg/ml), et sur *C. barbata* f. *aurantia*, il peut se prolonger jusqu'à 10-15 jours. Selon LEMÉE (com. pers.) la dégradation de la caulerpénine peut avoir lieu entre 24 et 48 heures; la possible toxicité des produits de sa dégradation est en cours d'étude.

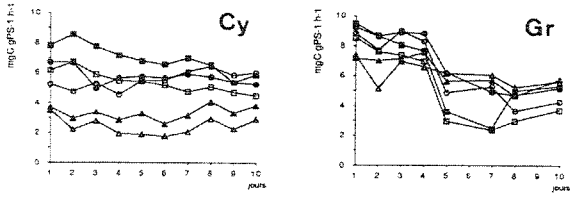


Fig. 1. **Hiver.** Courbes de productivité de *C. barbata* f. *aurantia* et *G. bursa-pastoris* des cultures à (■) 0; (□) 30; (●) 60; (○) 125; (▲) 250 et (△) 500 µg d'extrait de *C. taxifolia* / ml d'eau de mer.

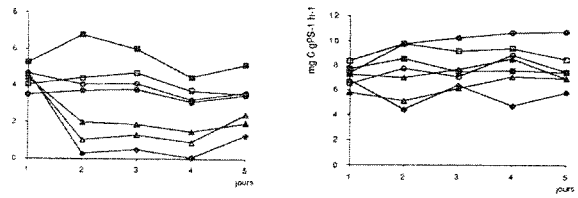


Fig. 2. **Printemps.** Courbes de productivité de *C. barbata* f. *aurantia* et *G. bursa-pastoris* des cultures à (■) 0; (□) 15; (●) 30; (○) 60; (▲) 125; (△) 250 et (◆) 500 µg d'extrait de *C. taxifolia* /ml d'eau de mer.

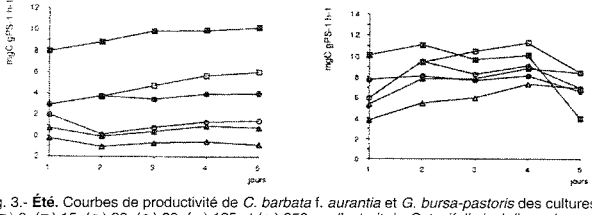


Fig. 3.- **Été.** Courbes de productivité de *C. barbata* f. *aurantia* et *G. bursa-pastoris* des cultures à (■) 0; (□) 15; (●) 30; (○) 60; (▲) 125 et (△) 250 µg d'extrait de *C. taxifolia* / ml d'eau de mer.

REFERENCES

DINI F., GUERRIERO A., GIUBBILINI P., MEINESZ A., PESANDO D., GUERRIERO A., MEINESZ A., D'AMBROSIO M. & PIETRA F., 1992. *Helv. Chim. Acta*, 75: 689-695.
DOTY M.S. & AGUILAR-SANTOS G., 1966. *Nature*, 211 : 990
FERRER E., GOMEZ GARRETA A. & RIBERA M.A., 1995. *Rapp. Comm. int. Mer Médit.*, 1995.
LEMÉE R., PESANDO D., DURAND-CLEMENT M., DUBREUIL A., MEINESZ A., GUERRIERO A. & PIETRA F., 1993. *Journal of Applied Phycology*, 5 : 485-493.
LITTLER M.M., 1979. *Aquatic Botany*, 7 : 21-34.
PAUL V.J. & FENICAL W., 1986. *Marine Ecology Progress Ser.*, 34 : 157.

INVESTIGATION OF GENOMIC POLYMORPHISM IN *POSIDONIA OCEANICA* PLANTS COLLECTED IN DIFFERENT AREAS OF MEDITERRANEAN SEA USING RAPD MARKERS

FRANCONI R.[1], G. BARCACCIA[2], A. PAGLIALONGA[3], C. MICHELI[3]

[1] ENEA CRE Casaccia, Settore Biotecnologie e Agricoltura, Italia
[2] Ist. di Miglioramento Genetico Vegetale, Univ. degli Studi di Perugia, Italia
[3] ENEA CRE Casaccia, Settore Scienze dell'Ambiente Fisico, Roma AD., Italia

The monoic *Posidonia oceanica* (L.) Delile is a marine phanerogame endemic of Mediterranean sea which has a multifunctional role in the coastal ecosystem (BOUDOURESQUE *et al.*, 1984). During these last years the progressive reduction of *Posidonia* meadows claimed the attention toward the recovery of this marine phanerogame by means of experimental transplantation of different populations. (MEINESZ *et al.*, 1993). It is well known that vegetative reproduction appears to be the principal mode of proliferation for this species (MEINESZ and LEFEVRE, 1984), and it is correlated with environmental parameters (depth, light and temperature). However the sexual reproduction remains the principal way to create and to preserve genetic variability. With the aim of better knowing the genomic polymorphism in *P. oceanica*, we performed a study using molecular markers such as RAPDs (Random Amplified Polymorphic DNA) (WILLIAMS *et al.*, 1990). During may-november 1993, several plants of *P. oceanica* were collected from 7 different geografical areas of the Mediterranean sea : Giannutri (GR), Costa dell'Argentario (GR), Scoglio dell'Argentarola (GR), Civitavecchia (RM), Ponza (LT), Marina di Camerota (SA) and La Valette (Malta). After collection by SCUBA diving, individual plants were washed in distillated water and stored in liquid nitrogen at -80°C. Subsequently, all extraction steps of genomic DNA were carried out following the protocol reported by DELLAPORTA *et al.*, (1983). The PCR conditions used were similar to those described by ECHT *et al.*, (1992) with some modifications involving reaction buffer and temperature ramps. Amplification reactions were carried out in a thermal cycler (Perkin Elmer/Cetus), using 8 different oligonucleotide primers. The sequences (5'-3') of the primers are as follows : (DN4) GTGGTGCTAT; (DN5) CCGACGGCAA; (DN6) TGGACCGGTG; (BY11) ATCCACTGCA; (BY12) GGTCGCAGGC; (BY13) CCTTGACGCA; (BY14) GGACCCTTAC (BY15) CTCACCGTCC. The amplification products were separated by gel electrophoresis (Agarose 1.4%) and photographs (Polaroid 667) were taken under U.V. light illumination after ethidium bromide staining. The RAPD assay was able to generate informative genomic fingerprints of the *Posidonia* plants. The detected product sizes ranged from 0.25 to 1.95 Kb, while the number of amplification products varied from 2 to 12 (on average 5.6) for plant. The frequency distribution concerning the total number of amplification products detected with all of the primers is shown in figure 1. Most of DNA segments amplified from the *Posidonia* genomic DNAs were 0.26 to 1.50 Kb in length. This histogram also emphasized the different ability of primers to find homologous binding sites among *P. oceanica* templates. On the whole, primer DN5 produced complex electrophoretic banding patterns characterized by the largest number of amplification products and by the widest range of product size (Fig. 2). In addition, this primer resulted the best in discriminating *P. oceanica* plants and, therefore, in detecting genomic polymorphisms. The analysis of electrophoretic profiles allowed the identification of conserved and individual specific amplification products. In particular, primer DN4 amplified several genomic fragments which resulted population conserved (excepted for two products which were absent in plants P11 and P17 collected in Civitavecchia coast) (Fig. 3). One primer out of eight (BY14) was not able to generate scorable bands while a couple of primers (BY11 and BY13) supplied little informations. In conclusion, an appropriate choice of the oligonucleotide primers and the investigation of a larger number of plants would give a reliable estimation of the level of genomic polymorphism within and between *P. oceanica* populations. The results above reported confirm that RAPD markers represent a valuable tool for investigations such as phylogenetic analysis and that they could be used for monitoring the diffusion of single genotypes after transplantation programs.

REFERENCES

BOUDOURESQUE C.F., A. JEUDY DE GRISSAC and J. OLIVER (Eds.), 1984. International Workshop on *Posidonia oceanica* Beds, GIS Posidonie, Marseille, France: 454 pp.

DELLAPORTA S. L., J. WOOD and J.B. HICKS, 1983. A plant DNA mini-preparation : version II. P.M.B.R., (1) 4 : 19-21.

ECHT G. S., L. A. ERDAHL and T. J. MCCOY, 1992. Genetic segregation of random amplified polymorphic DNA in diploid cultivated alfalfa. *Genome* 35 : 84-87.

MEINESZ A., CAYE G., F. LOQUES and H. MOLENAAR, 1993. Polymorphism and development of *Posidonia oceanica* transplanted from different parts of the Mediterranean into the National Park of Port-Cros, *Botanica Marina*, 6 : 209-216.

MEINESZ A and J.R. LEFEVRE, 1984. Regénération d'un herbier de *Posidonia oceanica* 40 ans après sa destruction par une bombe dans la rade de Villefranche sur mer (Alpes Maritimes-France). In: C.F. BOUDOURESQUE, A. JEUDY DE GRISSAC and J. OLIVER (Eds.) (1984): International workshop on *Posidonia oceanica* beds. GIS Posidonie Publ., Marseille, France, 1 : 99-104.

WILLIAMS J.G.K., A.R. KUBELIK, K.J. L, J.A. RAFALSKI and S.V. TINGEY, 1990. DNA polymorphisms amplified by arbitrary primers are useful as genetic markers. *Nucleic Acids Research*22 : 6501-6531.

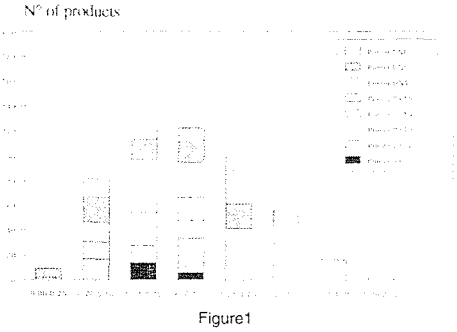


Figure1

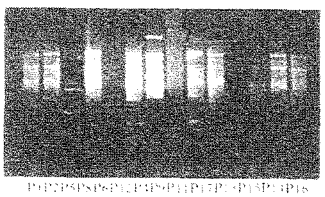


Figure 2

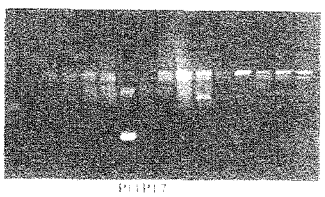


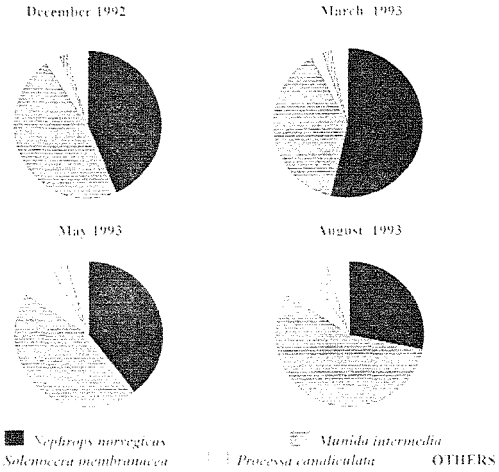
Figure 3

CRUSTACEA DECAPODA ASSEMBLAGE OF THE WESTERN POMO PIT. I - SPECIES COMPOSITION

Carlo FROGLIA and Maria Emilia GRAMITTO

Istituto di Ricerche sulla Pesca Marittima C.N.R. Ancona, Italy

The IRPEM, in the last twenty years, has extensively studied fishery resources and oceanography of the Western basin of the Pomo pit, a depression with a maximum depth of 256 m. The Pomo (Jabuka) pit is the main Nephrops ground in the Central Adriatic; moreover it is a nursery ground for hake (*Merluccius merluccius*). From December 1992 to April 1994, during a comparative study of different Mediterranean and Scottish Nephrops grounds, the area was sampled with an experimental unimesh prawn trawl with cod-end meshes of 12 mm stretch. Fish and decapod crustaceans made the bulk of the trawl catch. At least once per season catches obtained around noon and midnight were sorted on the deck for commercial species and the residual bycatch was frozen at sea and subsequently sorted in the laboratory. The seasonal quantitative composition of the Decapod assemblage has been estimated from the highest value of biomass per swept area obtained for each species, either in day time or night time. Diel change in vulnerability of different species has been estimated according to FROGLIA & GRAMITTO (1986). A total of 26 species of Decapod crustaceans have been identified, compared to 17 species listed for the same area by FROGLIA in 1976.



In the following table species are listed in systematic order and classified according to their habitat.

(P = pelagic, EB = epibenthic, BB = benthic making its own burrow, DB = benthic dwelling into sediments at least in some day period) and their diel vulnerability to trawl gear (N = highest catches at night, D = highest catches at day, I = without a clear diel pattern in catches). Species marked with an * were found only once with one or few individuals.

SPECIES	RANK number	RANK weight	Habitus	Vulnerab
Parapenaeus longirostris	15	11	EB	I
Solenocera membranacea	4	3	DB	N
* Sergestes arcticus	25	25	P	
* Pasiphaea sivado	23	20	P	
Alpheus glaber	11	14	BB	N
Processa canaliculata	5	4	DB	N
Processa nouveli	9	12	DB	N
Chlorotocus crassicornis	8	7	EB	N
Pandalina profunda	7	6	EB	N
Plesionika antigai	10	15	EB	
Plesionika heterocarpus	19	8	EB	D
* Plesionika martia	25	24	EB	
Aegeon lacazei	17	17	DB	
Philocheras echinulatus	16	9	DB	N
Pontophilus spinosus	7	5	DB	I
Nephrops norvegicus	3	2	BB	D
Calocaris macandreae	14	16	BB	N
*Callianassa subterranea	26	26	BB	
Jaxea nocturna	21	21	BB	
* Pagurus excavatus	24	23	EB	
Munida intermedia	1	1	EB	I
Macropodia longipes	20	20	EB	
Liocarcinus depurator	12	13	DB	I
Macropipus tuberculatus	13	13	DB	N
Goneplax rhomboides	18	18	BB	
Monodaeus cfr. couchii	19	19	DB*	

The decapod assemblage was dominated all the year round by *Nephrops norvegicus* and *Munida intermedia*, accompained by *Solenocera membranacea* and *Processa canaliculata*. The latter two species being vulnerable mostly at night. All the other species never made more than 5% by weight of the total decapod catch. The assemblage includes species characteristic of muddy bottoms of the circalitoral and epibathyal levels. Several of them are known to make burrows in sediments (ATKINSON, 1986) and their importance may be somewhat underestimated from trawl sampling. Thus *Calocaris macandreae* was observed only with single specimens in the trawl catches, but its density, estimated from 90 grab samples taken in the area in 1992 and 1993 (FROGLIA unpublished), had to be around 1 individual / 1.5 square metre.

REFERENCES

ATKINSON R.J.A., 1986. *Proc. R. Soc. Edinburgh*, 90B : 351-361.

FROGLIA C., 1976. *Thalassia jugoslavica*, 8(1): 75-79.

FROGLIA C. and GRAMITTO M.E., 1986. *FAO Fish. Rep.*, 345 : 111-118.

B

B

CRUSTACEA DECAPODA ASSEMBLAGE OF THE WESTERN POMO PIT. II - REPRODUCTION

Carlo FROGLIA and Maria Emilia GRAMITTO

Istituto di Ricerche sulla Pesca Marittima C.N.R. Ancona, Italy

Between December 1992 and April 1994, fishery investigations were carried out in the Western basin of the Pomo pit, the main Nephrops fishing ground of the central Adriatic, using an experimental prawn trawl with cod-end meshes of 12 mm stretch. The small mesh size of the gear made possible to gather ancillary data on the biology of the decapod species associated with *Nephrops norvegicus*. Reproductive strategies adopted by different species (see the review by WENNER & KURIS, 1991) may be responsible of their relative abundance in a particular environment. Therefore we considered worthwhile to summarize data on reproductive biology of the most common species in the decapod assemblage, gathered within this project and previous investigations, started over 20 years ago in the Western Pomo pit (FROGLIA, 1976).

In decapod crustaceans, Penaeoids excluded, females carry fertilized eggs underneath the abdomen untill the hatching of the larva. The period of incubation, characteristic of each species, is influenced by water temperature. Bottom temperature in the Pomo pit is rather constant and ranges between 10 and 11°C. Under these conditions the incubation period extends for 6 -7 months in the case of *Nephrops norvegicus* and for 3 months in the case of *Munida intermedia*.

The presence of ovigerous females in the trawl catches has been used to define the seasonality of the reproduction (TAB. 1). Ovigerous females of *Processa canaliculata* and *Chlorotocus crassicornis* were found all the year round suggesting the lack of an annual cycle. Other species have a marked annual cycle. For example females with ripe ovaries of *N. norvegicus* and *M. intermedia* were found respectively from late-spring to summer and in early autumn and the occurrence of ovigerous females was restricted to part of the year. The presence of mature ovaries in females carring eggs in advanced stage of development, was assumed as an indication of the possibility of multiple broods within the spawning season, as in the case of *Pandalina profunda*.

SPECIES	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Alpheus glaber	◆		◆		◆	◆	◆		◆			
Processa canaliculata	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	
Processa nouveli	◆	◆	◆	◆	◆		◆	◆	◆		◆	◆
Chlorotocus crassicornis	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆
Pandalina profunda	◆	◆	◆	◆	◆		◆				◆	◆
Plesionika antigai		◆	◆	◆	◆		◆					
Plesionika heterocarpus	◆	◆	◆	◆	◆		◆		◆	◆	◆	◆
Philocheras echinulatus			◆	◆	◆	◆					◆	◆
Pontophilus spinosus	◆		◆	◆								
Nephrops norvegicus	◆	◆	◆			◆	◆	◆	◆	◆	◆	◆
Munida intermedia	◆	◆								◆	◆	◆
Liocarcinus depurator			◆	◆			◆		◆	◆	◆	

Tab. 1 - Reproductive season of the most common species of Decapoda in the Western Pomo pit (based on the presence of ovigerous females)

Minimum and maximum size of ovigerous females are indicative respectively of the onset of first maturity and of the maximum size reached by the females in the area. Size is expressed as carapace length (c.l.) measured from eye socket to mid-posterior margin of carapace.

During the incubation period a percentage of developing eggs are lost from the pleopods. GRAMITTO & FROGLIA (1981) estimated that the number of hatching eggs is only 1/3 of the number of oocites for *Nephrops norvegicus*. Therefore only potential fecundity has been estimated, for comparative purposes between the most common species, by counting newly laid eggs (without evidence of embryo ocular pigment) in ovigerous females. In decapod crustaceans egg production is an exponential function of female length and in this preliminary note only minimum and maximum egg counts are given (Tab. 2).

SPECIES	Size (c.l.) mm min - max	Egg ∅ mm	Egg count min - max
Alpheus glaber	8.0 - 10.0	0.6 x 0.8	110 - 330
Processa canaliculata	13.0 - 21.0	0.5 x 0.7	1220 - 5770
Processa nouveli	6.2 - 11.6	0.4 x 0.5	760 - 1440
Chlorotocus crassicornis	11.5 - 20.5	0.6 x 0.8	240 - 1170
Pandalina profunda	3.9 - 5.5	0.4 x 0.5	110 - 380
Plesionika heterocarpus	9.0 - 17.4	0.5 x 0.7	710 - 4300
Philocheras echinulatus	5.5 - 10.5	0.6	240 - 1170
Pontophilus spinosus	11.0 - 14.5	0.6	1390 - 1990
Nephrops norvegicus	21.2 - 53.0	1.5	400 - 6000
Munida intermedia	9.5 - 21.0	0.7	1300 - 4910

Tab. 2 - Size (c.l.) of ovigerous females, egg diameter and potential fecundity

REFERENCES

FROGLIA C., 1976. Preliminary report on the Crustacea Decapoda of Adriatic deep waters. *Thalassia jugoslavica*, 8(1) : 75-79.

GRAMITTO M.E. and FROGLIA C., 1981. Osservazioni sul potenziale riproduttivo dello Scampo (*Nephrops norvegicus*) in Adriatico. *Mem. Biol. Marina & Oceanogr.*, 10 Suppl.: 213-218.

WENNER A. and KURIS A. (Eds.), 1991. Crustacean egg production. Crustacean Issues, 7 : 401 pp. Balkema, Rotterdam.

SPATIAL AND TEMPORAL VARIABILITY IN BIODIVERSITY IN RESPONSE TO SEWAGE SLUDGE DISCHARGE OFF THE MEDITERRANEAN COAST OF ISRAEL

Bella S. GALIL

National Institute of Oceanography, Israel Oceanographic & Limnological Research, P.O.B. 8030, Haifa 31080, Israel

Benthic assemblages have provided the most widely used parameters for assessing effects of waste discharges on the marine environment. The benthic invertebrate assemblage is considered an indicator of environmental quality because its components are relatively immobile and long-lived; thus they reflect the cumulative effects of exposure to environmental pollutants.

The Dan Region Wastewater project treats the sewage of the 1.3 million inhabitants of the Tel Aviv metropolitan area. Marine discharge of 14,000 m^3/day of sewage sludge begun in 1987. The outfall is 5 km offshore at water 37 m deep. A baseline survey of the area conducted in 1978 revealed no aberrant conditions. The benthic fauna was diverse and abundant and indicated the disposal area was unpolluted at the advent of dumping.

During Spring 1992, the environmental ministry initiated an improved monitoring program to measure the environmental effects of sludge discharge at the site. Twenty stations along two lines intersecting at the outfall were established, at distances of 50, 100, 200, 500 and 1000 m from the outfall, and triplicate 0.062 m^2 box core samples were taken at each in May and November 1992, October 1993 and May 1994. The samples were washed aboard ship through 0.5 mm screen and preserved in 10% buffered formalin. In the laboratory the samples were washed, preserved in 70% ethanol and stained with Rose Bengal. Organisms were identified and counted. The data have been analysed with the aim of distinguishing different associations of organisms and to examine any gradients through the data.

Sediments in the vicinity of the sewage sludge outfall were nearly devoid of benthic macrofauna, suggesting that accumulating sludge particles have a deleterious effect on the fauna. Further away from the most organically enriched area the assemblage was composed of few pollution tolerant species, including extremely abundant populations of one or two opportunistic species. Beyond the enriched zone assemblages gradualy approach the composition of the assemblage in the unpolluted environemnt and abundance values decline. The benthic assemblages found were dominated by polychaetes and bivalves, with a relative absence of crustaceans. Although the fauna at the sludge disposal site has shown significant degradation indicating modification of bottom environmental quality at and around the outfall, the size of the area affected fluctuated. In spring of 1992, samples collected 50 m from the outfall contained large numbers of capitellid polychaetes and little else, and those collected 100 m from the outfall contained large numbers of the bivalves *Abra alba* and *Corbula gibba*. In fall of 1992 and again in 1993, samples collected within an area delimited by the stations 1000 m north, 200 m east, 500 m south and 100 m west of the outfall, were nearly devoid of life. In spring of 1994, samples collected within 200 m of the outfall were extremely poor.

Available wave data indicate that at 37 m depth, near-bed currents capable of transporting fine sand occur only during particularly stormy winters. During fierce winter storms, wave induced motions near the sea bed rework the surface of the sediments, resuspending and widely dispersing the fine organic particles, sweeping the site clean of dumped material. Undisturbed accumulation of sludge takes place through the quiescent periods of the year. The winter of 1992 was stormy, thus by May 1992 the vicinity of the outfall was only little affected by sludge accumulation. The winter of 1994 was mild and indeed the fauna revealed the effects of increased organic loading. By fall these effects are exacerbated. The dispersive characteristics of the outfall site have prevented the perennial accumulation of organic substances. However, it appears that current rates of disposal have somewhat exceeded the dispersive capacity of the area, placing the fauna under stress and promoting the growth of pollution tolerant species. These changes are limited to a small area, but they suggest that further increases in sludge disposal may lead to more extensive, indicative and readily-identifiable effects.

OBSERVATIONS BIONOMIQUES DE L'INTERTIDALE DES CÔTES NORD DE SFAX (TUNISIE)

Mohamed GHORBEL, Asma HAMZA, Mohamed Nejmeddine BRADAI et Abdelwaheb ABDELMOULEH

Institut National Scientifique et Technique d'Océanographie et de Pêche, Sfax, Tunisie

L'étage intertidalprésente le même paysage d'Ellouza à Sfax. Avec une faible déclivité et un marnage important, ce littoral (30 km), présente des phénomènes particuliers et des peuplements variant légèrement suivant la nature du sédiment, l'orientation de la côte, la fréquentation et l'urbanisation du rivage. L'étude de l'étage intertidal de la région de Sfax n'a pas été faite auparavant. L'objet de cette note est de l'entamer et se limite dans un premier temps à la bionomie des côtes Nord de Sfax sur environ 6 km. Cette zone, telle que la concevait SEURAT (1929), correspond aux étages supra-littoral, médio-littoral et s'étend jusqu'à une étroite bande de l'infra-littoral photophile.

Cette frange littorale, connue par son activité de pêche artisanale, très urbanisée et industrialisée, sujette à des rejets chimiques et organiques importants, présente les caractéristiques bionomiques suivantes :

- Le cordon littoral, composé généralement par des feuilles mortes de cymodocées, des thalles d'ulves et de divers coquillages, n'est pas constamment présent. Il est très marqué par les cymodocées en automne, période de la chute foliaire de ces phanérogames. A la fin du printemps, ce sont les ulves qui jonchent les plages et avec les premières chaleurs de l'été dégagent des odeurs nauséabondes sous l'effet de la putréfaction.
- La zone médio-littorale s'étend jusqu'à 600 m du rivage. Le sédiment y est caractérisé par la présence d'une fine couche de sable jaunâtre couvrant un substrat vaseux noirâtre. A ce niveau, la faune est pauvre en nombre d'espèces; cependant l'abondance en nombre d'individus de la même espèce est souvent remarquable. Citons les polychètes errantes et sédentaires (*Perinereis cultifera, Nereis* sp., *Pomatoceros* sp.) qui colonisent le substrat, lui donnant souvent un aspect criblé par les concrétionnements de leurs tubes. Le gastéropode *Bithium reticulatum* abonde à ce niveau; lors de ses déplacements, il trace sur le fond marin des sillons tortueux remarquables. Les grandes quantités de naissains de lamellibranches à la surface du sédiment témoignent de la richesse de ce milieu en ces espèces.

Dans les flaques d'eau qui persistent après le retrait de la mer, prolifèrent généralement des poissons cyprinodon et de nombreux petits gastéropodes (*Cyclope neritea, Nassa donovani...*). Au printemps, ce sont surtout le lamellibranche *Solen marginatus* et la polychète *Spirographis spallanzani* qui colonisent ces petits plans d'eaux. Durant cette saison, les pontes de *Neverita josephinia* caractérisées par leurs formes de collerettes sont abondantes, surtout sur des substrats à débris coquillés.

La palourde *Ruditapes decussatus*, espèce faisant l'objet d'une collecte saisonnière et d'un commerce florissant, semble être plus abondante au voisinage des zones de rejets urbains. Les cardiums *Cerastoderma glaucum* côtoient souvent les palourdes et constituent même pour les collecteurs un indice de leur présence. Les cirripèdes *Balanus eburneus* sont rencontrés dans cet étage, là où il y a des substrats solides telles que les pierres, les planches et les bouteilles de différentes matières.

La flore, dans cette zone, est souvent masquée par les thalles d'ulves (*Ulva rigida*) qui atteignent des dimensions impressionnantes et s'accumulent au printemps sur les rivages, constituant ainsi le phénomène désigné sous le nom de marée verte. Lors de nos prospections, nous avons surtout recensé des algues vertes telles des cladophora, des bryopsis et des enteromorphes. Ces algues couvrent généralement tout ce qui est solide dans le milieu.

La présence de *Gracilaria bursa*, de *Gigartina acicularis*, de l'*Hypnea musciformis*, des *Ceramium* et de l'algue verte *Chaetomorpha linum*, dans l'étage médio-littoral, semble être due à leur entraînement de l'étage infra-littoral par la houle et les courants de marée.

Au printemps, le *Chondria tennuissima* et des *Polysiphonia*, surtout *Polysiphonia archnoïdae*, naissent et prolifèrent dans les flaques du médio-littoral leur donnant parfois quand elles sont observées de loin, une couleur rouge pourpre spécifique de ces espèces. Ces trois dernières années (1991-1994), en automne, nous avons constaté l'échouage en abondance de l'algue verte *Valonia macrophysa* constituant ainsi une nouvelle forme de marée verte.

A la limite inférieure de l'étage intertidale apparaissent les phanérogames *Zostera noltii* et *Cymodocea nodosa*. Dans cette zone, rarement immergée, apparaît une faune plus ou moins vagile et qui devient de plus en plus abondante avec l'augmentation de la densité foliaire de ces végétaux. Nous avons récolté en abondance le murex *Ocenebra erinacea* et le crabe *Carcinus aestuarii*. Ces deux espèces sont par ailleurs exploitées commercialement dans la région. Plusieurs espèces telles que les holothuries, les nudibranches *(Aplysia)*, habitants spécifiques surtout des herbiers de posidonie, commencent à se manifester dans ce biotope.

Du point de vue faunistique, il y a pauvreté en nombre d'espèces; celles-ci sont caractéristiques des substrats vaso-sableux et se développent en abondance dans cette région. La richesse du milieu en détritus organiques est évidente puisqu'une faune malacologique filtreuse et des détritivores y prospèrent. Ceci est dû essentiellement à la forte charge organique qui est constamment véhiculée et remaniée dans la zone.Du point de vue floristique, ce sont les ulves et certaines algues vertes qui colonisent cet étage intertidal du fait des grandes possibilités d'adaptation de ces espèces à la forte luminosité, à la nature du substrat et à l'importante charge organique du milieu.

REFERENCES

SEURAT L. G. 1929. Observations nouvelles sur les faciès et les associations animales de l'étage intercotidal de la petite Syrte (golfe de Gabès). *Bull. Stat. Océanogr. Salammbô*, 12 : 1 -59, carte.

EFFET DE *CAULERPA TAXIFOLIA* (VAHL.) C. AGARDH ET DE SES EXTRAITS MÉTHANOLIQUES SUR LE DÉVELOPPEMENT DES ZYGOTES DE *CYSTOSEIRA MEDITERRANEA* SAUV.

A. GOMEZ GARRETA, E. FERRER & M.A. RIBERA

Unitat de Botanica, Facultat de Farmacia,Universitat de Barcelona, Barcelona, Spain

Comme complément à l'étude de la toxicité de *Caulerpa taxifolia* sur le phytobenthos (FERRER *et al.*, 1995), des expériences de toxicité sur les zygotes de *Cystoseira mediterranea* ont été mises en place. D'autres auteurs ont déjà utilisé ces cellules dans des études de toxicité de différents produits (NORTH & JAMES, 1987). Des exemplaires de *Cystoseira mediterranea* ont été ramassés à Blanes (Girona, Espagne) en juin et en septembre, et mis à pondre, au laboratoire, sur des lames de verre placées dans des boîtes de Petri. Après 2 heures, la libération des zygotes a eu lieu et les boîtes de Petri sont alors introduites dans des aquariums de 2 litres de capacité. Le développement des zygotes en présence de *C. taxifolia* et en présence de différentes concentrations d'extraits (30, 125 et 500 µg/ml au printemps et 5, 30, 125 et 500 µg/ml en été) a été suivi. On a disposé d'un témoin en eau de mer et d'un autre en éthanol. Etant donné que les résultats du printemps ont démontré un effet nul de l'éthanol sur les oeufs, ce témoin n'a plus été utilisé en été. L'irradiance utilisée a été de 150 µE m^{-2} s^{-1}, la photopériode de 12:12 et la température de 18 et 25°C au printemps et en été respectivement.

Un comptage pour observer l'état des zygotes a été réalisé après 48 heures, temps nécessaire pour la fixation des oeufs, et un deuxième après 96 heures. Au printemps, tous les zygotes de chaque lame ont été observés; en été, par contre, le grand nombre de zygotes déposés sur les lames a conduit à n'en observer qu'un maximum de 100 par lame. Le traitement statistique des données a été fait par un test de t de Student (∞<0,05). Les zygotes de *Cystoseira mediterranea*, au laboratoire, commencent leur division 15-24 heures après la fécondation, et quelques heures plus tard, à partir de la troisième cellule formée (cellule rhizoïdale) se forment les rhizoïdes (GUERN, 1963). Le comportement du témoin pendant les deux expériences (printemps et été) a été conforme aux prévisions, avec une proportion élevée de zygotes segmentés avec des rhizoïdes développés (80%). Les zygotes avec de l'éthanol ainsi que ceux avec *C. taxifolia* n'ont pas présenté de différences significatives avec le témoin. Par contre, la présence des extraits, aussi bien au printemps qu'en été, donne lieu à des modifications du développement de ceux-ci (Fig. 1 et 2).

Pour toutes les concentrations d'extraits, un pourcentage élevé de zygotes (15-40%) avorte par éclatement de la membranne externe. D'autre part, à partir de 125 µg/ml au printemps et de 30 µg/ml en été se produit l'inhibition de la formation de rhizoïdes. A des concentrations plus basses, l'effet semble s'atténuer et le pourcentage entre zygotes éclatés et zygotes à rhizoïdes était semblable. En été, avec une concentration de 5 µg/ml, un ralentissement du développement des zygotes a été observé, puisque la formation de rhizoïdes a été presque nulle jusqu'au deuxième jour et ne s'avère importante (40%) qu'à partir du troisième jour. Cette récupération après 3-4 jours de culture à des concentrations basses, pourrait être due à la dégradation de la caulerpénine dans l'eau de mer.

En conclusion, il apparaît que la présence de produits du métabolisme de *C. taxifolia* dans l'eau de mer, à certaines concentrations, pourrait empêcher la fixation sur le substrat des zygotes de certains macrophytes.

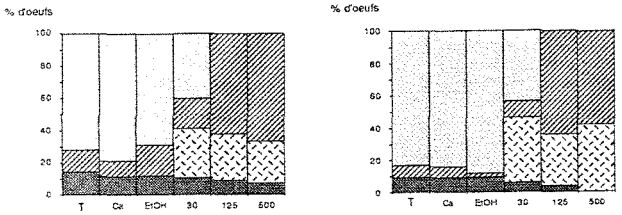


Fig. 1.- Effet des extraits de *C. taxifolia* sur le développement des zygotes de *C. mediterranea* au printemps. (▨segmentés sans rhizoïdes, □ segmentés avec rhizoïdes, ▩ éclatés, ■ non segmentés). **T**:témoin; **Ca**:avec *Caulerpa*; **EtOH**:avec éthanol; **30, 125, 500**: µg/ml d'extrait.

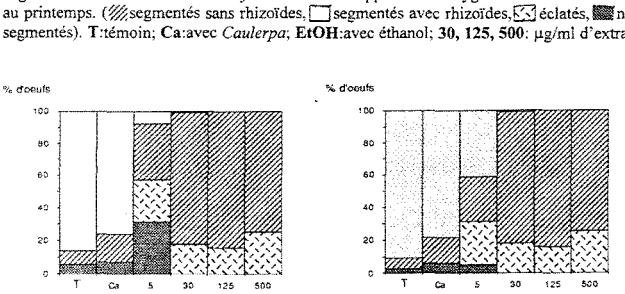


Fig. 2.- Effet des extraits de *C. taxifolia* sur le développement des zygotes de *C. mediterranea* en été. (▨ segmentés sans rhizoïdes, □ segmentés avec rhizoïdes, ▩ éclatés, ■ non segmentés). **T**:témoin; **Ca**:avec *Caulerpa*; **EtOH**:avec éthanol; **5, 30, 125, 500**: µg/ml d'extrait.

REFERENCES

FERRER E., RIBERA M.A. & GOMEZ GARRETA A., 1995. Effet des extraits de *Caulerpa taxifolia* (Vahl.) C. Agardh sur deux macrophytes méditerranéennes. *Rapp. Comm. int. Mer Médit.* 34.

GUERN M., 1963. Embryologie de quelques espèces du genre *Cystoseira* Agardh 1821 (Fucales). *Vie Milieu*, 13 (4) : 649-679.

NORTH W.J. & JAMES D.E., 1987. Use of *Cystoseira* and *Sargassum* embryonic sporophytes for testing toxicity effects. *Hydrobiol.*, 151/152 : 417-423.

B

ASCIDIAN FAUNA OF THE SUEZ CANAL

Y. HALIM[1], M. ABDEL MESSIH[2], M. MIKHAIL[1] and M. SHABANA[1]

[1]Faculty of Science, [2] National Institute of Oceanography and Fisheries, Alexandria, Egypt

Apart from the coastal waters of Alexandria (HARANT, 1936; KHALIL, 1962; ABDEL-MESSIH,1982) and of the Suez Canal (HARANT, 1926; MONNIOT and MONNIOT, *in* POR and FERBER, 1972) little is known about the Ascidians of Egyptian waters. An extensive seasonal survey was carried out in 1988-1990 along the Egyptian Mediterranean coast, the Suez Canal and part of the Northern Gulf of Suez. This paper reports briefly on the status of the Suez Canal Ascidian fauna, about sixty years after the report of HARANT (1926). The collection examined by MONNIOT and MONNIOT (POR and FERBER, 1972) was more limited in scope. HARANT (1926) recognized 25 species,the majority of which were of Red Sea-Indo-Pacific origin. The present survey shows the Suez Canal Ascidian fauna to have been enriched since by 14 newly established species (Table). The new records comprise nine Red Sea-Indo-Pacific Ascidians. Thus, the well known predominance of the southern species in the Canal is maintained.

The Canal fauna is remarkably diverse in contrast with the paucity in species of the Mediterranean localities examined : of a total of 51 species recorded from Egyptian waters, 40 were contributed by the Canal. Their distribution however is not uniform. The southernmost segment, including the Small Bitter Lake down to Suez, is the poorest with only five species. Diversity improves in the Great Bitter Lakes with 12 species and comparatively large populations. It is in the middle and northern segments of the Canal that a diverse population was found to flourish. Twenty nine species growing in massive aggregations were collected from the two segments. *Styela partita, S. canopus, Ascidia nigra, Polyclinum constellatum* and several *didemnids* were dominant and abundant.

Polyclinum constellatum is recorded as a new species for the Mediterranean. While it was absent from the records of HARANT and rare in those of MONNIOT and MONNIOT, it is at present widespread in the Canal and was found to be settled in Damietta harbour. *P. constellatum* provides a further case of progressive northward extension of a Red Sea species.

Three Mediterranean species were recorded as southward migrants : *Macroclynum duboscqui var.orientale, Distomus variolosus* and *Microcosmus sulcatus*. The latter two were represented at El Ghardaqa although by rare specimens. *Macroclynum duboscqui var. orientale*, unknown before from Egyptian waters, occurs at the two ends of the Canal and also at El Ghardaqa. This is the first record of southward migration of Mediterranean Ascidians in the Red Sea.

It is obvious that the Canal fauna has not reached its climax, as thought by POR and FERBER (1972). The process of colonization of the Canal and of immigration to both seas is still going on, as also concluded by HALIM (1990) for plankton.

Table. New Ascidian records from the Canal.

Ascidia obliqua, A. prunum, Botryllus schlosseri, Didemnum amethysteum

D.e dmondsoni, D. acazeii, D. moseleyi, Ecteinascidia imperfecta, Molgula occidentalis,

M. siphonalis, Perophora listeri, P. viridis, Styela plicata,

Tridid emnum savignii var. joelensis.

REFERENCES

ABDEL MESSIH, M.K.,1982. Studies on Ascidians in Alexandria waters. M.Sc. Thesis, Faculty of Science, Alexandria University.

HALIM, Y.,1990. On the Potential Migration of Indo-Pacific Plankton through the Suez Canal. *Bulletin de l'Institut Oceanogr.*, Monaco, n° special 7, pp 11-27.

HARANT, H.,1927. Rapport sur les Tuniciers. Zoological Results of the Cambridge Expedition to the Suez Canal,1924. Trans. Zool. Soc. London, 22(3), pp 365-373.

HARANT, H., 1939. Les fonds de pêche près d'Alexandrie. Ascidiacea. Notes and Memoirs, Inst. Fouad 1 Hydrobiol. Pêches, Egypte, (28) pp1-7, (5 cartes).

KHALIL, S.H., 1962. Studies on protochordates of Alexandria. M.Sc. Thesis, Faculty of Science, Alexandria University.

POR, F.D. and I. FERBER, 1972.The Hebrew University - Smithsonian Institution Collections from the Suez Canal (1967-1972). *Israel Journal of Zool.*, 21 :149-166.

LES MARÉES VERTES SUR LES CÔTES NORD DE SFAX (TUNISIE)

Asma HAMZA, Mohamed Nejmeddine BRADAI, Mohamed GHORBEL et Abdelwaheb ABDELMOULEH

Institut National Scientifique et Technique d'Océanographie et de Pêche, Sfax, Tunisie

La prolifération et l'accumulation massive de macro-algues vertes apparentes sur certaines plages ont pris de l'ampleur ces dernières années au point de vue quantitatif, mais aussi en ce qui concerne le nombre de plages touchées. Ce phénomène de marées vertes était en effet peu connu il y a 20 ans. Actuellement, plusieurs plages du littoral tunisien sont atteintes par ce fléau. Le phénomène est spectaculaire sur les côtes nord de Sfax. Dans notre zone d'étude, deux algues vertes sont à l'origine de ce phénomène : *Ulva rigida et Valonia macrophysa*. L'apparition de cette dernière est relativement récente (3 à 4 ans). Au mois de mars 1994, une nouvelle marée à *Chaetomorpha linum* a été observée sur ce littoral. Plusieurs facteurs régissent généralement les marées vertes :

- les mouvements hydrodynamiques, et surtout la marée, qui assurent le transport et l'accumulation des algues sur le littoral ainsi que l'oxygénation en permanence de ces biomasses,
- la faible déclivité et l'immensité des plages exposées à l'éclairement,
- la richesse du milieu en nutriments donnant ainsi aux algues vertes des sources potentielles pour leur développement,
- les grandes températures, le fort ensoleillement, ...

Dépendant étroitement de ces facteurs irréguliers, l'apparition et les concentrations (biomasses) de ces algues sont variables dans l'espace et dans le temps. Nos observations et le suivi de ce phénomène sur les côtes nord de Sfax ces dernières années nous ont permis de situer les périodes d'abondance des deux espèces algales responsables de ces marées vertes (fig. 1). Les biomasses maximales des ulves sont enregistrées au printemps lors des périodes d'éclairement maximum (fig. 2), alors que celles des *Valonia* paraissent être conditionnées par les concentrations en nutriments et se situent de ce fait en automne, période pendant laquelle les apports terrigènes et la dégradation des algues et phanérogames échouées sur les rivages sont importants.

L'apparition des deux algues sur les rivages nord de Sfax (Sidi Mansour-Ellouza) pendant les périodes de vives eaux présente des alternances et des périodicités suivant les saisons (fig.3). Au printemps, les ulves se manifestent en abondance sur le littoral durant les périodes de vives eaux, les *Valonia* sont souvent masquées et n'apparaissent qu'au troisième jour. Les ulves qui sont dotées de thalles foliacés facilement détachables sont entraînées les premières, les *Valonia* formées par contre de thalles globuleux en vésicules ne sont acheminées que plus tard et sont souvent masquées par l'abondance des ulves.

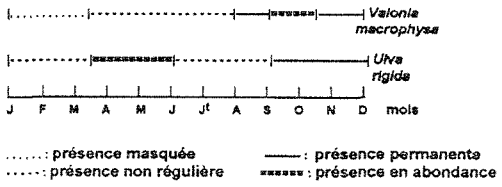


Figure 1 : degré d'abondance de *Valonia macrophysa* et *Ulva rigida* selon les mois (1993)

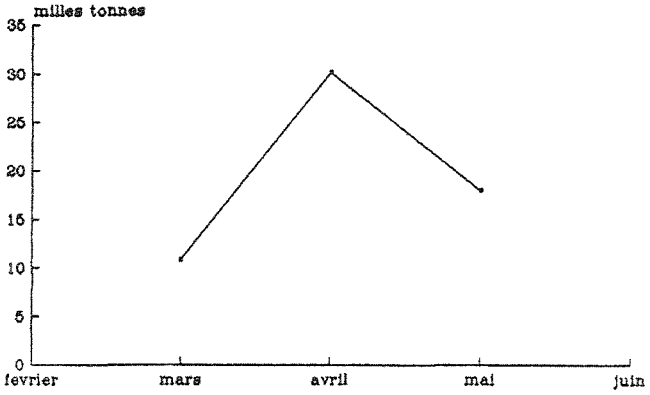


Figure 2 : biomasse des ulves des côtes nord de Sfax (1994)

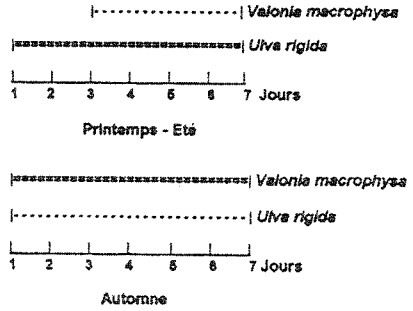


Figure 3 : alternance et périodicité d'*Ulva rigida* et *de Valonia macrophysa* pendant les périodes de vives eaux.

A MARINE CAVE AS A MESOCOSM OF THE DEEP MEDITERRANEAN

J.G. HARMELIN, N. BOURY-ESNAULT, J-C ROMANO, E. VACELET and H. ZIBROWIUS

Centre d'Océanologie de Marseille, Université d'Aix-Marseille II - URA-CNRS n° 41, Station Marine d'Endoume, rue de la Batterie des Lions, 13007 Marseille, France

The deep Mediterranean is relatively poor in animal species. The warm homothermy below 300 m (approximately 13°C) is a limiting factor for many bathyo-abyssal animals and a number of important deep-sea groups are absent or poorly represented. For this reason the Mediterranean is considered to be of little interest in deep-sea biology. However, the homogeneity of the whole water column during the cold season, the local narrowness of the continental shelf, and the adaptation of the deep-sea fauna to a relatively constant high temperature have allowed some bathyal bottom dwellers to establish themselves in shallow water caves. This offers opportunities for studies of several problems of deep-sea biology.

Submarine caves share several ecological features with deep-sea habitats, such as the absence of light, the lack of photosynthetic production, a low flux of organic matter, a poor food supply and a low level of hydrodynamic energy (RIEDL, 1966; FICHEZ, 1990, 1991). Both communities depend on allochthonous organic input, and bathyal species have been found in the darkest parts of littoral caves (HARMELIN *et al.*, 1985). Faunal and environmental similarities, however, are limited by the obvious differences in pressure, temperature, habitat size, and by the dispersal abilities of deep-water organisms. We have found a Mediterranean cave which more closely approximates deep-sea conditions, due to the entrapment of a cold water mass resulting in stable temperature conditions throughout the year (BOURY-ESNAULT *et al.*, 1993; VACELET *et al.* 1994). Easily accessible to scuba divers, this "bathyal island" in the littoral zone is a natural mesocosm of the deep Mediterranean which contains an unusual abundance of examples of bathyal organisms unrecorded in "normal" caves with the same temperature regime as open shallow waters (CASANOVA, 1992; LOGAN & ZIBROVIUS, 1994).

A large population of *Oopsacas minuta*, a representative of the bathyo-abyssal hexactinellid sponges, reproduces here year round - making possible the first observations of larval behavior and ultrastructure to be carried out on this phylogenetically important group of invertebrates, and opening the poorly known area of larval ecology of these deep-sea sponges (BOURY-ESNAULT & VACELET, 1994). The presence of a species of the deepest known genus of sponges, *Asbestopluma* (8840 m in the Central Pacific) is a fascinating opportunity to investigate the biology of the strange deep-sea cladorhizid sponges, which may live in the most oligotrophic abyssal basins. A highly unexpected result is that they are non-filter-feeding "sponges" with a carnivorous feeding habit. Devoid of aquiferous system, they capture and digest small crustaceans by means of filaments provided with minute hook-shaped spicules (VACELET & BOURY-ESNAULT, 1994).

A sediment layer on the floor, several meters thick, has recorded the history of the cave and of its biodiversity through bioclasts. Time-lapse photographs have shown that spoke-like traces resembling those on the abyssal sea floor are made by the proboscis of an echiuran worm, a behavioural study of which, in progress, will be highly informative about the deep-sea traces. Results on the particle content of the trapped water mass, the microbial activity and the degradation of organic material during transfer along the cave (120 m long) address the problem of fluxes of organic material in the deep-sea.

This easily accessible "bathyal island" in the sublittoral zone offers exceptional opportunities for observations and experiments that may provide important insights into such problems of deep-sea biology as colonization, microbial ecology, fluxes of organic material and metabolic physiology, cytology, reproduction, and dispersal strategy in existing, and even translocated, deep-sea species.

REFERENCES

BOURY-ESNAULT, N., J. G. HARMELIN, & J. VACELET. 1993. Les abysses méditerranéennes à 20 m de profondeur ? *La Recherche* , 24 : 848-851.

BOURY-ESNAULT, N. and J. VACELET. 1994. Preliminary studies on the organization and development of a hexactinellid sponge from a Mediterranean cave, *Oopsacas minuta*. *In:* Sponges in time and space: Biology, Chemistry, Paleontology. (Eds: van Soest,RWM; van Kempen,TMG; Brackman,JC) A.A. Balkema, Rotterdam, 407-4016.

CASANOVA, J.-P. 1992. Les chaetognathes cavernicoles de la Méditerranée nord-occidentale : adaptations et spéciation, comparaison avec l'Atlantique. *Bull. Inst. océanogr.*, Monaco n° spécial 9 : 83-100.

FICHEZ, R. 1990. Decrease in allochtonous organic imputs in dark submarine caves, connections with lowering in benthic communities richness. *Hydrobiologia*, 207 : 61-69.

FICHEZ, R. 1991. Benthic oxygen uptake and carbon cycling under aphotic and resource-limiting conditions in a submarine cave. *Mar. Biol.*, 110 : 137-143.

HARMELIN, J. G., J. VACELET, & P. VASSEUR. 1985. Les grottes sous-marines obscures : un milieu extrême et un remarquable biotope refuge. *Téthys*, 11(3-4) : 214-229.

LOGAN, A., & H. ZIBROWIUS. 1994. A new genus and species of rhynchonellid (Brachiopoda, Recent) from submarine caves in the Mediterranean sea. *P.S.Z.N.I. Mar. Ecol.*, 15(1) : 77-88.

RIEDL, R. 1966. Biologie der Meereshöhlen. Verlag Paul Parey, Hamburg und Berlin. 636 pages.

VACELET, J., N. BOURY-ESNAULT, & J. G. HARMELIN. 1994. Hexactinellid Cave, a unique deep-sea habitat in the scuba zone. *Deep-Sea Res.*, 41(7) : 965-973.

VACELET, J. and N. BOURY-ESNAULT. 1994. Non-poriferan Porifera : carnivorous deep-sea sponges without aquiferous system. *Nature* (in press).

L'ÉCOSYSTEME DU GOLFE DE GABÈS : DÉGRADATION DE SON COUVERT VÉGÉTAL ET DE SA PÊCHERIE BENTHIQUE

Abdallah HATTOUR[1], Karim BEN MUSTAPHA[1], Brahim TURKI[1], Mohamed MHETLI[1] et Bèchir TRITAR[2]

[1] INSTOP, 28 rue du 2 mars 1934, 2025 Salammbô, Tunisie
[2] Faculté des Sciences de Tunis, Le Belvédère, Tunisie

Le golfe de Gabès constitue l'échancrure la plus importante affectant la côte tunisienne. Il est limitée au nord par les hauts fonds de Kerkennah, au Sud et à l'Ouest par le continent et à l'Est par la rupture du plateau continental. Les caractéristiques essentielles de la région méridionale sont une pente faible et un relief absent, ce qui donne lieu à un plateau continental très étendu (l'isobathe 200 mètres est à 250 kilomètres du port de Gabès). Le golfe de Gabès constitue une zone de frai propice à un grand nombre d'espèce mais aussi des nurseries pour les jeunes individus. Les fonds où la "chalutabilité" est aisée, sont généralement sableux à sablo-vaseux. Trois ports hauturiers se situent sur cette côte (Sfax, Gabès et Zarzis), en plus des onze ports côtiers.

La pêche. C'est l'existence de la crevette qui a spécialement favorisé un chalutage abusif et mal contrôlé à de très faibles profondeurs. Cette activité anthropique a contribué à l'instauration d'une biocénose caractérisée par des variations brusques de ses facteurs biotiques et abiotiques. Ces variations ont occasionné des dommages, peut-être irréversibles, au développement naturel de ses communautés. On n'hésite plus actuellement à parler non de dégradation ou de régression, mais de phénomène de disparition des ressources naturelles ou de désertification des fonds marins du golfe de Gabès affectant aussi bien l'herbier de posidonie que la pelouse de caulerpe.

La très forte densité de chalutiers, en augmentation systématique depuis 1983, passant de 200 à 393 unités en 1991 (CGP,1991), opérants sur une aire de pêche traditionnellement limitée à des faibles profondeurs a entraîné au fil des années par le raclage aveugle, intensif et incontrôlé des fonds marins :

-1. l'arrachage de la végétation (prairie de posidonie et pelouse de caulerpe),

-2. la diminution importante des stocks d'animaux marins de première qualité par la pêche de ces derniers à de petites tailles non commercialisables et rejetés en mer. Ces rejets qui atteignent 70% de la prise commerciale, ont été estimés à 51 000 tonnes, soit presque la production globale de la région (HATTOUR, 1991).

-3. l'appauvrissement de la faune benthique (coquillage, étoiles de mer, oursins, holothuries, crabes, vers, etc.) en effectif et en diversité. Le fond du golfe est devenu gris blanchâtre avec quelques îlots de spirulines plus ou moins importants selon les zones et quelques ascidies.

La pollution industrielle. L'industrialisation de la région de Gabès a été caractérisée par l'implantation, dans les années 70 à Ghannouch, d'un complexe chimique en vue de transformer annuellement plus de trois millions de tonnes de phosphates de CPG (Compagnie de Phosphate Gafsa). Depuis, deux grandes sociétés sont opérationnelles, en l'occurrence la SIAPE (Société des Industries d'Acide Phosphorique et d'Engrais) et la SAEPA (Société Arabe des Engrais Phosphatés et Azotés). Les nuisances occasionnées par cette activité industrielle ont affecté l'air, la terre et la mer de cette région qui a vu ses potentialités économiques se dilapider, notamment dans les secteurs du tourisme, de l'agriculture et de la pêche .

Parmi les modifications importantes qui ont affecté le milieu marin du golfe de Gabès, sous l'effet des rejets de phosphogypse estimés jusqu'à nos jours à plus de 40 millions de tonnes, nous pouvons citer :

-1. l'enrichissement de l'eau en éléments phosphatés, azotés et sulfatés,

-2. l'opacification importante des eaux aussi bien par les composantes solides provenant des rejets et mises continuellement en suspension que par les *blooms* phytoplanctoniques. Si au nord-est de Zarat, le disque de Secchi disparaît entre 3 et de 4 mètres, au niveau des rejets il disparaît dès les premières dizaines de centimètres. A titre de comparaison, au golfe de Hammamet, le disque disparaît à plus de 30 mètres.

-3. l'accélération du processus d'envasement sur toute la frange côtière du golfe de Gabès, un recouvrement massif et surtout fatal des fonds, provoquant l'ensevelissement de tous les organismes benthiques qui y vivent,

-4. l'accumulation des substances traces dans les sédiments et les organismes marins avec notamment une concentration importante de cadmium et de plomb.

Cette détérioration de l'environnement marin qui touche toute la frange côtière du golfe a entraîné :

- la régression très importante des posidonies,
- la disparition presque totale des caulerpes,
- l'appauvrissement quantitatif et qualitatif de la faune benthique,
- la transformation de la pêcherie du golfe de Gabès —traditionnellement à vocation benthique avec des espèces nobles à haute valeur commerciale— en pêcherie à vocation pélagiques ciblant particulièrement les sardines.

B

B

BIODIVERSITY OF "COCKETRICE" SANDY BANK (BLACK SEA) - A PREREQUISITE FOR ITS CONSERVATION AS A PROTECTED AREA

T. KONSOULOVA, J. TOKMAKOV

Depart. of Marine Biology and Ecology, Inst. of Oceanology, 9000 Varna, Bulgaria

Considering the growing in the last years interest shown by various economic organizations to take sand from the Black sea natural deposits for construction purposes, as well as the negative effect registered after such activity along the coast of Ukraine (Odessa), detailed oceanological investigations -including direct observation of the "Cocketrice" sandy bank- have been carried out during 1986-89 period (DIMITROV *et al.*, 1990). This bank, discovered by the English oceanographic vessel "Cocketrice" in 1887, is located in the North-Eastern part of the Bourgas Bay - the greatest and most polluted bay along the Bulgarian Black sea coast (Fig. 1). Accor-

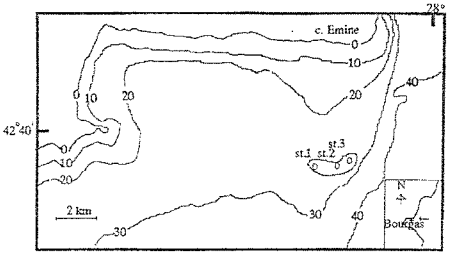


Figure 1 : sampling stations

ding to the main results obtained, the highest part of the bank is 16.2 m deep, the sand is of a mean grain size composition and the potential sand stock amounts to about 126 mln.t. The unusual location of the cresting bank with hardened sections in some high disposed zones and relatively strong streams in its eastern part predispose favourable conditions for the development of the typical for the rocky sublittoral *Mytilus galloprovincialis* population. These data gave grounds for conclusions that the specifying of the biota status in this reef-like structure is of a special interest having in mind that it is located in the most ecologically threatened zone along the Bulgarian Black sea coast and the need to estimate the ecological effect after a possible sand exploitation is obligated. Moreover, the results obtained would be a definite contribution at present when there is a pronounced tendency to use artificial reefs along the Bulgarian sector of the Black sea for restoration of the destructed coastal ecosystems.

Sampling from three stations (at 18, 21 and 22 m depth) by Van-Veen grab, covering 0.1m^2 has been carried out seasonally during 1991-92. The samples were washed through a set of sieves (the last one with 0.6 mm mesh size) and fixed in 4% formaldehyde. All macrozoobenthic specimens were defined to species level (excluding *Nemertini, Turbellaria* and *Oligochaeta*), counted and weighed. The Sorensen's coefficient of similarity and Shannon Weaver H-index were calculated; the species abundance/biomass comparison method was used for detecting pollution effect (WARWICK, 1986). A total of 92 macrozoobenthic species and groups are registered in all stations (st.1-18 m; st.2-21 m; st.3-22 m depth), the most numerous of which are *Polychaeta* (34), followed by *Crustacea* (29) and *Mollusca* (22). According to Sorensen's coefficient (48.2) the most shallow zoocoenosis (st.1) strongly dominated by *Mytilus galloprovincialis* is differentiated as a specific one, that necessitates a separate discussion of the results. The species composition in this station consists of a total of 65 species and groups (including *Pisces* larvae) among which prevails *Polychaeta* (25), while *Crustacea* and *Mollusca* are presented by 20 and 16 species respectively. The number of species varies slightly seasonally from 35 during the summer to 39 during the winter. In the total abundance (14492 ind/m^2) *Mollusca* predominates (60.6%) presented mainly by *M. galloprovincialis* (48.4%) together with sparsely distributed *Chamelea gallina* (8.3%). The seasonal maximum in abundance is in summer (20925 ind/m^2), *Crustacea* showing the most intensive (3.2 times) increase. The total biomass (4045.0 g/m^2) is structured mainly by *Mollusca* (99.4%) the two basic species M. *galloprovincialis* and *Ch. gallina* presented by 57.7% and 38.0% respectively. The average H-index value (2.93) varies slightly seasonally : from 2.7 during the summer to 3.3 during the spring. The results show that a specific zoocoenosis has been formed in this highest zone of the sandy bank : it combines the characteristic features of the two richest zoocoenosis - the *Mytilus* rocky and sandy ones. The registered *Pisces* larvae (20 ind/m^2) testify to the existence of favourable conditions for ichthyofauna reproduction and development.

The high degree of similarity between macrozoobenthic communities in st.2 and 3 (75.2) gave ground to analyze their data unified. The species composition in this part of the sandy bank is more various; from the total of 80 species and groups, 30 are *Polychaeta*, 25 *Crustacea* and 19 *Mollusca*. The species diversity increases from 42 species registered in spring to 60 in the summer, from which *Polychaeta* and *Crustacea* are almost equally presented (20 and 19 species respectively). In the total abundance (13149 ind/m^2), *Polychaeta* prevails throughout the year (63.5%) while the rest of the quantity consists of *Crustacea* (16.6%) and *Mollusca* (17.2%), a structure typical for sandy zoocoenosis. The maximum abundance is registered during the summer (24537 ind/m^2) which is due to a certain degree to the *Pisces* larvae high quantity (7090 ind/m^2). The summer is the season with the highest H-index value also : 3.74 (average H = 3.48). In the total biomass (1730.0 g/m^2) prevails *Mollusca* (88.96%) with the typical sandy species *Ch. gallina* predomination (61.36%). A comparative analysis with the Bourgas Bay zoobenthic communities status shows that : 1/ the species diversity is considerably lower (54 species); 2/ a tendency for maximum abundance drop is registered during the crucial summer period (39 times *Crustacea* density reduction); 3/ the average density and biomass are almost 10 times lower; 4/ the communities are characterized as "grossly" and "moderately polluted"; 5/ *M. galloprovincialis* population dies during the summer as a result of the deteriorated environmental conditions (hypoxia), that prevent the population from reproduction in the Bay (STOYKOV *et al.*, 1994).

Consequently, the "Cocketrice" sandy bank is a nature reserve inhabited by unique zoobenthic coenoses differentiated from the adjacent region by the following peculiarities : 1/ high biodiversity and sustainable abundance and biomass structure, that determine their ecological status as "unpolluted" throughout the year; 2/ the presence of a normally functioning *M. galloprovincialis* population which as the most powerful biofilter among the Black sea *Mollusca* contributes to the de-eutrophication of the area; 3/ the presence of some threatened by extinction *Crustacea (Upogebia pusilla)*; 4/ *Pisces* larvae great quantity presence defines this bank as a spawning area. All these prerequisites determine the imperative need for preventing the "Cocketrice" sandy bank as a protected area.

REFERENCES

DIMITROV, P., E. DEMIREV, J. CHERNEVA, D. SOLAKOV. 1990. Rep. Int. Symp. Geolog. monit. geoecol. probl. Baltick and Black sea, Pitersburg, Russia.
STOYKOV, S. *et al.*, 1994. *Proc. Inst. Fish.*, Varna, 22 : 5-57.
WARWICK, K.M. 1986. *Mar. Biol.*, 92 : 557 - 562.

LIGHT LIMITATION OF *POSIDONIA OCEANICA* (L.) DELILE GROWTH AT DIFFERENT DEPTHS

M. LORENTI, L. MAZZELLA, M. C. BUIA

Lab. di Ecologia del Benthos, Stazi. Zoologica di Napoli, 80077 Ischia Porto (Na), Italy

Although several factors could be responsible for seagrass distribution and production patterns, light plays a major role in both growth rates and depth distribution (BUIA *et al.*, 1992; DUARTE, 1990). Reduction of light resources, due to environmental quality deterioration, contributes to the regression phenomena which make *Posidonia oceanica*, endemic of the Mediterranean Sea, an endangered species. The wide depth distribution shown by *Posidonia* translates into a variety of irradiance environment. The relationships between the light regime, production features and allocation of carbon has been approached in the case of other seagrass species such as *Zostera marina* (ZIMMERMANN *et al.*, 1991), *Thalassia testudinum* (FOURQUREAN and ZIEMAN, 1991) and others (POLLARD & GREENWAY, 1993). The objectives of the present research were to highlight :

- the role of photoperiod and available irradiance levels in explaining leaf growth patterns at different depths and light regimes,
- the role of belowground metabolic demand in the whole-plant carbon balance.

Two stands located at 5 m and 22 m respectively along a depth gradient at Lacco Ameno (Ischia, Gulf of Naples) were chosen. They are characterized by different structure (e.g. shoot density, Leaf Area Index) and growth patterns (BUIA *et al.*, 1992). Photosynthetic features were estimated measuring oxygen evolution through Clark-type electrodes of leaf tissues of different ages. Respiration by leaves and belowground tissues (roots and rhizomes) were estimated by the same methods. By knowing the leaf standing stock, these parameters were referred for each stand to the unit area (square meter). *In situ* PAR irradiance was periodically measured by a quanta meter and the average attenuation coefficient of local water column was calculated. By knowing the irradiance at which saturation of photosynthesis is achieved (Ik), the *in situ* maximum noon irradiance (Im) and the photoperiod, the daily period of saturating irradiance (Hsat) was assessed (DENNISON & ALBERTE, 1985). Hcomp, i.e. the daily period of irradiance above compensation light (Ic), was also estimated.

Stands at 5 m and 22 m showed variations in Pmax (maximum photosynthesis) mainly related to different leaf ages found in the different seasons (ranges are between 0.72 and 1.5 mgC/gdw/h at 5 m, and between 0.72 and 1.04 mgC/gdw/h at 22 m). However, in both stands low Ik ranging from 40 to 65 uE/m^2/sec were found, ensuring an optimal exploitation of light energy available. Belowground respiration is generally one order of magnitude lower than shoot respiration (0.05 vs 0.3 mgC/gdw/h, on the average). Hsat ranged from 14.4 hours (May) to 9.6 (November) at 5 m, and from 7.4 (May) to 4.9 hours (November) at 22 m (Fig.1). By combining production rates and respiration rates with the Hsat periods in the four seasons, a carbon balance was obtained for the unit area of the two stands. At 5 m, the maximum was achieved in May with 4.3 gC/m^2/day whereas the minimum occurred in January (0.6). At 22 m, a maximum was also achieved in May (0.2 gC/m^2/day) while in winter negative values were found (- 0.03 in Jan. and - 0.27 in Nov.). When Hcomp was taken into consideration, balance values at 22 m in winter were substantially raised (0.04 gC/m^2/h in Jan., - 0.14 gC/m^2/h in Nov.) (Fig.1).

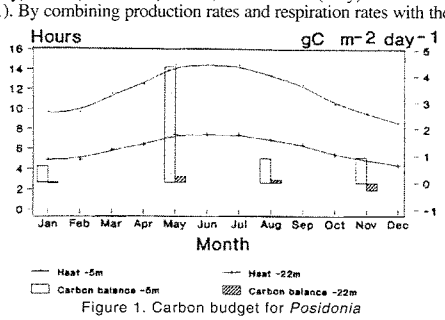


Figure 1. Carbon budget for *Posidonia*

The Hsat required to balance carbon demand, estimated by respiratory demand of the whole plant, as referred to the entire biomass, was largely reached and exceeded at 5 m in all four seasons, whereas at 22 m a deficit occurred in winter (Fig. 2). Light limitation seems to largely account for differences in growth patterns and production levels between the two stands; however plant is adapted to overcome this limitation and to grow along depth gradients :

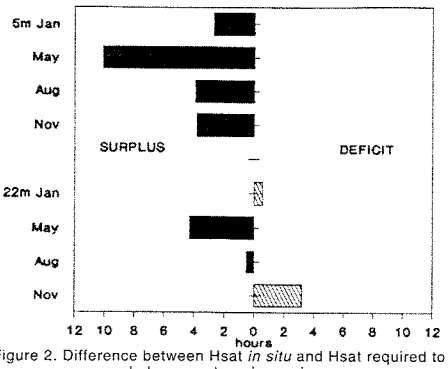


Figure 2. Difference between Hsat *in situ* and Hsat required to balance carbon demand.

- belowground tissues, despite the high biomass, have a low metabolic demand in comparison to the shoots;
- surplus production with respect to shoot growth, occurring in spring-summer, can be stored in the belowground tissues (PIRC, 1985) and can compensate for the depression of production due to biotic and abiotic factors.

As a result, although the plant has acquired adaptation to life at low irradiance, light limitation could be a factor for the rising of depth limit of *P. oceanica* contributing to the regression of its beds and consequently to the reduction of the high biodiversity which characterizes such systems. The role of *Posidonia oceanica* as a "biomass storer" through accumulation of belowground tissue is crucial in the coastal systems of the Mediterranean Sea making the species one of the most important structural component of complex ecosystems.

REFERENCES

BUIA M.C., ZUPO V., MAZZELLA L., 1992. *P.S.Z.N.I. Marine Ecology*, 13 : 2-16.
DENNISON W.C. and ALBERTE R.S., 1985. *Mar. Ecol. Prog. Ser.*, 25 : 51-61.
DUARTE C., 1991. *Aquat. Bot.*, 40 : 363-377.
FOURQUREAN J.W. and ZIEMAN J.C., 1991. *Mar. Ecol. Prog. Ser.*, 69 : 161-170.
PIRC H., 1985. *P.S.Z.N.I. Marine Ecology*, 6 : 141-165.
POLLARD P.C. and GREENWAY M., 1993. *Aust. J. Mar. Freshwater Res.*, 44 : 127-139.
ZIMMERMAN R.C., REGUZZONI J.L., WYLLIE-ECHEVERRIA S., JOSSELYN M. and ALBERTE R.S., 1991. *Aquat. Bot.*, 39 : 353-366.

RESEARCH IN PROGRESS ON *POSIDONIA OCEANICA* IN THE LIGURIAN SEA, WESTERN MEDITERRANEAN

G. MATRICARDI

"Development models of aquatic organisms research" group. Istituto di Anatomia Comparata dell'Università di Genova, Viale Benedetto XV, 5, 16132 Genova, Italia

In recent years, *Posidonia oceanica* (L.) Delile has been extensively studied by many authors in several coastal regions of the Mediterranean (BOUDOURESQUE *et al.*, 1984; BOUDOURESQUE *et al.*, 1989). However, data on the distribution and phenology of the *posidonia* meadows are still fragmentary and little informing for large areas of this sea. Excluding some little meadows in the Gulf of Trieste and the not well investigated eastern coast of the Adriatic Sea, the Ligurian Sea is the northern distribution area of the seagrass. It is characterized by surface climatic conditions (temperature and salinity) which differ from the neighbouring Gulf of Lions (generally colder and more aline) and Tyrrhenian Sea (warmer during winter) (PICCO, 1990). Few and localized information on *Posidonia* meadows in the Ligurian Sea is available from litterature : BIANCHI and PEIRANO (1990) supplied a complete and discussed bibliography; unfortunately this work, which is followed by a detailed mapping (scale 1:25.000) of the meadows of the whole Liguria province, has not been published. Other available mappings mainly refer to Portofino Promontory and Cinque Terre area on the east coast of Liguria, and to the region between Cogoleto and Loano on the west coast (BIANCHI *et al.*, 1987). Furthermore, most of the existing bibliography provide faunistic information, omitting data on phenology, morphology, upper and lower limit features, etc.

The research group "Development models of aquatic organisms" of the Comparative Anatomy Institute of the University of Genova, working from 1986 on growth strategies in marine invertebrates, engaged in investigations on *P. oceanica* as a support information on the ecosystem in which the selected target species lived. Given the lack of data, the first aim was to obtain detailed maps of the investigated meadows. A simple and fast acoustic technique has been developed to provide information also on the density of the prairie (WURTZ *et al.*, 1988). By this technique, density maps of Spotorno (8°26'E, 44°14' N), Cogoleto (8°39' E, 44°24' N), and Nervi (9°2' E, 44°23' N) meadows have been obtained (scale 1:10.000); in the same areas, permanent transects have been localized and described to set up an historical data base on the evolution of the meadows. While investigations on the morphology and the growth strategy of *Electra posidoniae* Gautier (Bryozoa, Cheilostomata) on *posidonia* leaves were carried on (MATRICARDI *et al.*, 1991), data on shoot density (40x40 cm quadrats), leaf number and measures (by age classes; GIRAUD, 1979), leaf base measure, apex condition, brown tissue extension and the index of epiphytism (MORRI, 1991) were collected on a seasonal sampling design and at different depths (0-30 m). According to GIRAUD (1977), preliminary data suggest to classify Nervi meadow as "Stade IV: herbier très clairsemé" (mean density : 216.7 shoots/m^2, 15 m depth), Prelo meadow (Portofino Promontory) as "Stade II : herbier dense" (mean density : 427 shoot/m^2, 5 m depth) and Spotorno meadow as "Stade II" (mean density: 181.5 shoots/m^2, 10 m depth); detailed data are still necessary to describe better shoot densities in the meadows. Statistical comparisons with similar data coming from other mediterranean regions will provide information on morphological differences related to environmental conditions. In the Spotorno and Nervi meadows, monthly investigations have been planned from 1994 to describe the leaf cycle of the plant, performing, by multivariate statistics, a better estimate of the mean dimensions of each leaf in the bundle during the year. More general information on the *Posidonia* ecosystem interactions are collected in the Spotorno meadow.

Some peculiar topics about *P. oceanica* biology have also been investigated. Flowerings have been observed at Cala dell'Oro (Portofino Promontory - 9°10' E, 44°19' N - 22 m depth, 1992) and Sori (9°7' E, 44°23' N - 4 m depth, 1993) (unpublished data). The phenology of a recent *Posidonia* settlement on hard substrate is monitored from 1992 at Cogoleto, in order to obtain information about the development of a prairie (DAVICO and MATRICARDI, 1995).

Field operations have been supported by the Sezione di Quinto of the Lega Navale Italiana, the Noli Diving College and the Gruppo Subacqueo Sori, to which our best thanks are addressed for the pretious collaboration. The main results of the researches listed above will be the subject of detailed works in the future.

REFERENCES

BIANCHI C.N., MORRI C., PEIRANO A., ROMEO G. and TUNESI L., 1987. Bibliografia ecotipologica sul Mar Ligure. Elenco preliminare. ENEA, Collana Studi Ambientali, Roma : 1-90.

BIANCHI C.N. and PEIRANO A., 1990. Mappatura delle praterie di *Posidonia oceanica* in Mar Ligure. ENEA-CREA S. Teresa, Rapporto Tecnico interno : 1-372.

BOUDOURESQUE C.F., JEUDY DE GRISSAC A. and OLIVIER J. (Eds.), 1984. First International Workshop on *Posidonia oceanica* Beds. GIS Posidonie, Marseille : 1-454.

BOUDOURESQUE C.F., MEINESZ A. and FRESI E. (Eds.), 1989. Second International Workshop on *Posidonia oceanica* Beds. GIS Posidonie, Marseille : 1-321.

DAVICO L. and MATRICARDI G., 1995. Phenology of a recent *Posidonia oceanica* settlement in the Ligurian Sea, Western Mediterranean. *Rapp. Comm. int. Mer Médit.*, 34.

GIRAUD G., 1977. Essai de classement des herbiers de *Posidonia oceanica* (L.) Delile. *Botanica Marina*, 20 : 487-491.

GIRAUD G., 1979. Sur une méthode de mesure et de comptage des structures foliaires de *Posidonia oceanica* (Linnaeus) Delile. *Bull. Mus. Hist. Nat. Marseille*, 39 : 33-39.

MATRICARDI G., MONTAGNA P. and PISANO E., 1991. Settlement and growth strategies of Electra *posidoniae* Gautier on *Posidonia oceanica* (L.) Delile. *In*: "Bryozoaires actuels et fossiles : Bryozoa living and fossil", F.P. Bigey (Ed.), *Bull. Soc. Sci. Nat.* Ouest Fr., Mem. HS 1 : 255-262.

MORRI C., 1991. Présentation d'un indice synthétique pour l'évaluation de l'épiphytisme foliaire chez *Posidonia oceanica* (L.) Delile. *Posidonia Newsletter*, 4 (1) : 33-37.

PICCO P. (Ed.), 1990. Climatological atlas of the western Mediterranean. ENEA S. Teresa Centre, La Spezia : 1-224.

WURTZ M., REPETTO N. and MATRICARDI G., 1988. A simple and fast method to obtain rough density maps of the *Posidonia oceanica* beds. *Rapp. Comm. int. Mer Medit.*, 31 (2) : 316.

MODELLING THE SPATIAL DISTRIBUTION AND ASSESSMENT OF *NEPHROPS NORVEGICUS* (L.) BY GEOSTATISTICS

F. MAYNOU[1], G. Y. CONAN[1] AND F. SARDÀ[2]

[1] Gulf Fisheries Centre, Dept. Fisheries & Oceans, Moncton, N.B., E1C 9B6 Canada
2 Institut de Ciències del Mar, Pg. Joan de Borbo, s/n. 08039 Barcelona, Spain

B

An extenisve survey was carried out in order to accurately map the distribution and assess the harvestable biomass of *Nephrops norvegicus* by geostatistics. The survey site is located off Tarragona (NE Spain), at shelf and slope depths (84.5 to 713 m) on commercial fishing grounds. The area surveyed was 939.5 km^2. Sampling was carried out from 6 to 16 May 1994 over 72 stations, using a specially designed otter trawl (Maireta System, SARDÀ *et al.*, 1995). In order to retain small individuals, a 12 mm cod-end stretched mesh was fitted to the trawl. Opening of the trawl was measured by a SCANMAR acoustic system, stabilizing at 16 m width and 2 m height. Tows were made parallel to the depth contours and lasted 15-30 min. Start and end locations were measured by G.P.S., and area swept by the trawl was computed exactly. The survey was carried out over 24 h periods, but only preliminary results for day-time samples are presented here.

In order to accurately map and further estimate the density of Norway lobster individuals, the geostatistical technique was applied (MATHERON, 1971; JOURNEL and HUIJBREGTS, 1978, CONAN *et al.*, 1992). The linear geostatistical method is a two stage optimal interpolation method. First, the spatial structure of dependence is examined by computing experimental semivariograms. A semivariogram is a form of autocovariance function which analyzes the spatial dependence among samples. In the case of spatial independence among samples, the mathematical expectation of the semivariogram function is the variance of the population. The existence of spatial astructuration in the population is revealed by a monotonously increasing semivariogram up to the distance (called range) in which the effects of spatial dependence are negligible, the stabilizing around the sample variance (called sill). Experimental semivariograms computed for Norway lobster samples in the study area showed a structure of variability stabilizing around 5-7 km, for all biological categories selected (adult males and females, juvenile males and females), in accordance with previous results from nearby areas (CONAN *et al.*, 1992). In order to proceed to the actual mapping or spatial prediction stage, the experimental semivariogram must be modeled by a theoretical semivariogram function which complies with certain mathematical conditions (MATHERON, 1971). A spherical model was fitted (sill = 3.742, range = 7.2 km, figure 1). The fit was very similar for all biological categories considered, thus only results for total density of *Nephropss* are presented. The mapping was conducted by estimating the density of individuals over an arbitrarily fine grid on the polygon defined by presence of positive samples (200 to 600 m depth, except for a shallower zone on the shelf of the Ebro delta). The (linearly) optimal interpolator is obtained is obtained solving the point kriging system of linear equations at each point of the grid. The resulting map is presented in figure 2. The geostatistical technique of block kriging (MATHERON, 1971) was implemented over the mapped area to obtain estimates of the density of *Nephropss* individuals and total biomass. The kriging or estimation variance obtained when solving the system of equations was used to set confidence limits to our estiamtes. Average density computed by kriging was 341.5 ± 218.3 ind/km^2 and total number of individuals was 320,905.8 ± 205,065.2 or 6,420 ± 4,010 kg.

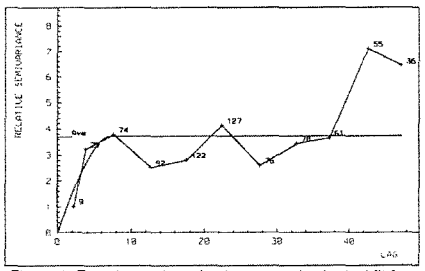


Figure 1: Experimental semivariogram and spherical fit for total number of Norway lobster:

Geostatistics, as a tool for mapping the distribution of a species and assessing the potential of the resource, proves adequate for benthic resources presenting a complex pattern of spatial structuration, such as *Nephrops norvegicus*. Confirming previous results (CONAN *et al.*, 1992), Norway lobster populations are structured in patches of high density of around 7 km in diameter. A preliminary analysis of the night-time samples reaveals the same pattern and location of high-density patches, although at much lower density (due to the light-dependent catchability of the species). Adult and immature (< 26 mm CL) individuals show the same pattern of spatial distribution and high-density patches overlap extensively for biological categories, which could be of importance in the management of the resource. Due to the complex biological cycle of the species (seasonal variability of catchability, especially of berried females) and its burrowing habits, the application of geostatistics is limited by other factors than those properly pertaining to the spatial modelling stage and should be utilized within a concepyual biological model for the species.

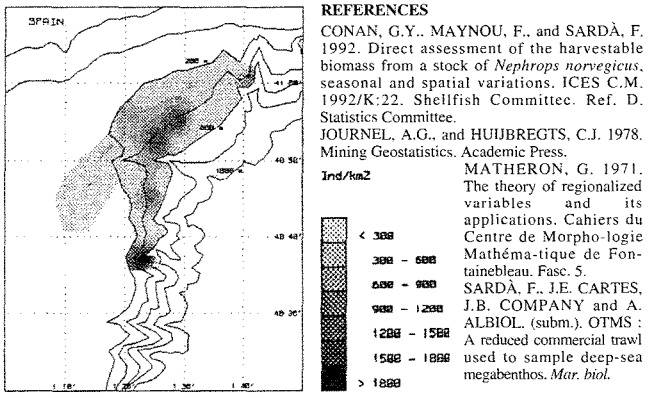


Figure 2: Density map of *Nephrops norvegicus* produced by kriging

REFERENCES

CONAN, G.Y., MAYNOU, F., and SARDÀ, F. 1992. Direct assessment of the harvestable biomass from a stock of *Nephrops norvegicus*, seasonal and spatial variations. ICES C.M. 1992/K:22. Shellfish Committee. Ref. D. Statistics Committee.

JOURNEL, A.G., and HUIJBREGTS, C.J. 1978. Mining Geostatistics. Academic Press.

MATHERON, G. 1971. The theory of regionalized variables and its applications. Cahiers du Centre de Morpho-logie Mathéma-tique de Fontainebleau. Fasc. 5.

SARDÀ, F., J.E. CARTES, J.B. COMPANY and A. ALBIOL. (subm.). OTMS : A reduced commercial trawl used to sample deep-sea megabenthos. *Mar. biol.*

B

THE DAILY INTAKE AND DEGREE OF ABSORPTION OF THE SEA URCHIN PARACENTROTUS LIVIDUS FED UPON *CAULERPA TAXIFOLIA* (CHLOROPHYTA), *CYSTOSEIRA COMPRESSA* AND *HALOPTERIS SCOPARIA* (FUCOPHYCAE)

Valérie MENAGER, Luke PUDDY and Charles-François BOUDOURESQUE

LBMEB and EP CNRS No 75, Faculté des sciences de Luminy, 13288 Marseille cedex 9, France

The tropical green algua *Caulerpa taxifolia* (Vahl) C. Agardh was introduced into the Mediterranean sea in 1984 (MEINEZ and HESSE, 1991), where it forms very dense populations in the infralittoral zone, in particular between Nice and Menton (Alpes-Maritimes, France). *Caulerpa taxifolia* is toxic due to the production of some toxic terpenoids (GUERRIERO *et al.*, 1992 ; LEMEE *et al.*, 1993). The algas' toxicity changes greatly according to the season : in March-April, it is as its weakest and is most toxic from July to November (LEMEE *et al.*, 1993). During the hot season the sea urchin *Paracentrotus lividus* (Lamarck, 1816) notably avoids *Caulerpa taxifolia* ; on the other hand, during the cold season, the urchin is likely to feed upon the alga; however, the gonads of urchins fed upon *Caulerpa taxifolia* are found to be significantly less developped when compared with those of urchins fed upon a control alga (LEMEE *et al.*, 1994). The purpose of these experiments is to understand the reasons for these observations.

The experiments were carried out in aquariums, between the months of March and May 1994. The temperature of the water in the aquariums was constantely adjusted to correspond with the temperature of the sea in the region of the Alpes Maritimes. The algae offered to the urchins (*C. taxifolia*, *Cystoseira compressa* (Esper) Gerloff and Nizamuddin, *Halopteris scoparia* (Linnaeus) Sauvageau were gathered less than one week beforehand (except for experiment 2). The intake was measured by the daily weighing of the algae (measurements adjusted to take into account any growth of the algae). The degree of absorption was measured by calculating the difference between the intake and the faecal weight.

In all the experiments the urchins display phases of 1-3 days of feeding divided by phases of fasting lasting 1-2 days. These phases explain the significance of the standart deviations (Table 1). The intake of urchins fed upon *Caulerpa taxifolia* is significantely lower than those of urchins fed upon *Cystoseira compressa* and especially *Halopteris scoparia*, two algae considered to be moderately or strongly prefered, respectively by *Paracentrotus lividus*. The degree of absorption is found to be between 0 and 7% for urchins fed upon *Caulerpa taxifolia* as opposed to between 7 and 34% for urchins fed upon the two other algae. Futhermore, if *Caulerpa taxifolia* is freshly gathered (experiments 1, 3 and 4), all urchins feeding upon it are found to be dead within 14 to 18 days after the beginning of the experiment. On the other hand, there is no mortality for the urchins fed upon *Caulerpa taxifolia* conserved for longer than 15 days in an aquarium (experiment 2). However, the intake and the degree of absorption (this in particular) remain low.

Algae offered	Experiment N°	Dates	Daily Intake Mean	Daily Intake Standard deviation	degree of absorption %
Caulerpa taxifolia	1	March 25 - April 4	8	6	0
	2	April 18 - May 19	41	32	2
	3	April 10 - April 22	13	19	0
	4	May 6 - May 20	42	38	7
Cystoseira Compressa	5	March 25 - May 19	89	55	34
	6	April 18 - May 19	59	45	7
Halopteris scoparia	7	March 25 - May 19	134	96	23
	8	April 18 - May 19	121	77	13

Table 1 : Intake (in mg of dry weight/day/individual) and the degree of absorption (as a % of the mass ingested) of *Paracentrotus lividus*.

In the cold season, when *Caulerpa taxifolia* is at its least toxic, *Paracentrotus lividus* will feed upon the alga. However, the intake and the degree of absorption (this in particuler) are very low, which explains the observed mortalities, as well as the underdevelopement of the gonads reported by LEMEE *et al.* (1994). Furthermore, the conservation in an aquarium of *Caulerpa taxifolia* probably alters its chemical composition and hence this parameter must therefore be taken into account in the experimental protocols.

Acknowledgements. This work was performed within the scope of the programm CEE-DG XI "L'expansion de l'algue verte tropicale *Caulerpa taxifolia* en Méditerranée".

RÉFÉRENCES

GUERRIERO A., MEINESZ A., D'AMBROSIO M. and PIETRA F., 1992. Isolation of toxic and potentially toxic metabolites sesqui- and monoterpenes from the tropical green seaweed *Caulerpa taxifolia* which has invaded the region of Cap Martin. *Helvetica Chimica Acta*, 75 : 689-695.

LEMEE R., BOUDOURESQUE C.F., MARI X. and MEINESZ A., 1994. Influence d'une nourriture exclusive à base de *Caulerpa taxifolia* sur la physiologie de *Paracentrotus lividus*. International Workshop on *Caulerpa taxifolia*, BOUDOURESQUE C.F., MEINESZ A. and GAVEZ. edit., GIS posidonie publ. (in press).

LEMEE R, PESANDO D., DURAND-CLEMENT M., DUBREUIL A., MEINESZ A., GUERRIERO A. and PIETRA F., 1993. Preliminary survey of toxicity of the green alga *Caulerpa taxifolia* introduced into the Mediterranean. *Journal of applied Phycology*, 5 : 485-493.

MEINESZ A. and HESSE B., 1991. Introduction et invasion de l'algue tropicale *Caulerpa* taxofolia en Méditerranée occidentale. *Oceanologica Acta*, 14 (4) : 405-426.

SEASONAL EFFECTS OF *CAULERPA TAXIFOLIA* (VAHL.) C.AGARDH ON THE GROWTH OF *PHAEODACTYLUM TRICORNUTUM* BOHLIN

MERINO V., CLAVERO E., RIBERA M. & HERNANDEZ-MARINE M.

Laboratory of Botany. Faculty of Pharmacy. University of Barcelona, Spain

Caulerpacean algae sinthetize many toxic secondary metabolites as a defense against grazers and epiphytes (PATTERSON *et al.*, 1984). Recently introduced populations of *Caulerpa taxifolia* (Vahl) C. Agardh in the Mediterranean sea also produce these substances, some of them (caulerpenyn) even in higher concentration than in the tropical ones (GUERRIERO *et al.*, 1992). This toxicity is liable to seasonal variations, as shown by toxicity experiments against mice, urchins and mammalian cells (LEMEE *et al.*, 1993). Since the mediterranean populations of *C. taxifolia* are extremely denses, an undesirable impact may be produced on both planktonic and benthic microalgae. As they are the first step in the food web and play an important ecological role in the sea, if microalgae population are affected by *C. taxifolia*, the whole ecosystem will be.

Our goal is to check whether *C. taxifolia* is toxic for some marine microalgae growing in laboratory culture conditions and to verify the existence of seasonal differences in the *C. taxifolia* effect on them. We will show the results obtained for *Phaeodactylum tricornutum* Bohlin a pennate diatom common in supralittoral rock pools, and extensively used in laboratory work and aquacultural systems to feed the invertebrate juveniles. *C. taxifolia* was collected at days 20/11/93, 28/2/94, 22/5/94 and 1/9/94 on the French coasts of Cap Martin at 9 m depth, and immediately transported to the laboratory in aerated opaque containers. Each toxicity test were started the day after. Unialgal cultures of *P. tricornutum* were supplied by Dr. Lubian, ICMA (CSIC), Cadiz. Cultures were maintained in artificial seawater (ADSA-Micro) enriched with f/2 Guillard's medium (GUILLARD & RYTHER, 1962) in a growth chamber set at 20°C on an alternating 12:12 LD cycle at 100 $\mu E.m^{-2}.s^{-1}$ cool-white fluorescent lighting. Subcultures were previously acclimated for a period of 2 weeks at the temperature at which the experiment was to be conducted (the same registred in the sea when *C. taxifolia* were collected: 15°C, 12°C, 17°C and 25°C respectively). Six culture vessels containing 200 ml sterile medium were inoculated to give initial population densities around 10^4 cells ml^{-1}. Simultaneously, two fragments consisting on both blades and stolons of *C. taxifolia* (2 g each) were added simultaneously to 4 of them. One millilitre aliquots from thoroughly mixed cultures were withdrawn daily for a period of 27 days (25 days for winter experiment), and preserved with a drop of formaldehyde. Cell counts were performed with a Coulter Multisizer-2.

	Autumn		Winter		Spring		Summer	
	Cont.	Caul.	Cont.	Caul.	Cont.	Caul.	Cont.	Caul.
Max. Growth Rate	0.84	0.29	0.72	0.57	1.75	0.56	0.58	0.1 5
Max. Cell Concentration	28	11	15	2.6	4.8	1.4	4.3	1.3

Table I. Growth rate (div./day) and maximum cell concentration (cells/ml x 10^5) for both control (Cont.) and test (Caul.) experiments.

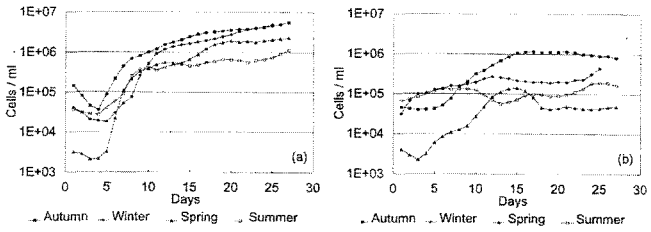


Fig. 1 Growth curves for control (a) and test cultures (b) in the four seasonal experiments.

Smoothed growth curves (fig. 1) showed a less growth in test cultures than in controls, in every season. Sligthly different profiles among control growth curves could be explained by temperature and initial cell concentration. Obviously, test cultures were also affected by these two factors, but differences among the control and test curves were too large for these factors to account for them. There were observed different behaviours in the growth of test cultures among the different seasons. A lag-phase was present in the autumn and spring test cultures but not in the other seasons. The slope and the lenght of the exponential growth phase changed in the different seasons, and so the number of cells at the end of the exponential growth changed too. When maximum growth rates and maximum cell concentrations were considered it appeared that, in all the seasons, they both were lower in test cultures than in controls (Table I). Maximum growth rate pointed to summer and spring test cultures as the most different to the controls (3.85 and 3.12 times lower) (Table I). Maximum cell concentration for spring and summer experiment were 3.54 and 3.22 times lower in test cultures than in controls (Table I) and although winter experiment showed the highest difference between test and control cultures (5.77 times lower) this result, due to a ciliate proliferation had to be discarded. The ciliate growth could be the cause of the inhibition of the diatom growth instead of the *C. taxifolia* effect. Moreover, in this season collected *C. taxifolia* was strongly epiphyted. That fact together with the ciliate growth might point out that the macroalga was less toxic (LEMEE *et al.*, 1993; DINI *et al.*, 1992).

Then, we can conclude that, in the experimental conditions described, control/test culture ratios of the maximum growth rate and maximum cell concentration at the end of the exponential phase were the best features to compare the effect of *C. taxifolia* in different seasons and that *P. tricornutum* is highly affected by *C. taxifolia*, specially in summmer and spring. Anyway, the extrapolation of these results to the natural environment is to be considered carefully since culture conditions in the laboratory differ from the environment where *C. taxifolia* developes.

REFERENCES

DINI F., GUERRIERO A., GIUBBILINI P., MEINESZ A., PESANDO D., DURAND-CLEMENT M., PIETRA F., 1992. Ciliates as a probe for biological pollution produced by the seaweed *Caulerpa taxifolia*. Third Asian Conference on ciliate..., Shenzen, China, July 1-6, 8.1

GUERRIERO A., MEINESZ A., D'AMBROSIA M. & PIETRA F., 1992. Isolation of toxic and potentially toxic sesqui- and monoterpenes from tropical green seaweed *Caulerpa taxifolia* which has invaded the region of Cap Martin and Monaco. *Helvet. Chim. Acta*, 75 : 689-695

GUILLARD R.L.L. & RHYTHER J.H., 1962. Studies on marine planktonic diatoms. I. *Cyclotella nana* Hust. and *Detonula confervacea* (Cl.) Gran. *Can. J. Microbiol.*, 8 : 229-239

LEMEê R., PESANDO D., DURAND-CLEMENT M., DUBREUIL A., MEINESZ A., GUERRIERO A. & PIETRA F., 1993. Preliminary survey of toxicity of the green alga *Caulerpa taxifolia* introduced into the Mediterranean. *J. Appl. Phycol.*, 5 : 485-493

PATTERSON G.M.L., NORTON T.R., FURUSAWA E., FURUSAWA S., KASHIWAGI M. & MOORE R.E., 1984. Antineoplastic Evaluation of Marine Algal Extracts. *Bot. Mar.*, 27 : 485-488.

FLORAISON DE BOUTURES ORTHOTROPES DE *POSIDONIA OCEANICA* APRÈS UN DÉPLACEMENT BATHYMÉTRIQUE LORS DE LEUR TRANSPLANTATION

Heike MOLENAAR, Gilberte CAYE & Alexandre MEINESZ

Lab. Environnement Marin Littoral EP 75 CNRS, Univ. de Nice-Sophia Antipolis, France

La floraison de *Posidonia oceanica* (L.) Delile ne s'observe que dans des zones d'herbier très localisées qui correspondraient à des clones répartis en mosaïque dans les peuplements. En effet, CAYE & MEINESZ (1992) pensent que la période de floraison est limitée dans le temps, en particulier elle apparaîtrait après une période juvénile plus ou moins longue. Les paramètres susceptibles d'agir sur l'induction de la floraison de *P. oceanica* n'ont pas été testés en aquarium, comme pour la plupart des autres phanérogames marines, puisque cette floraison a rarement été obtenue dans ces conditions. En effet, seules deux floraisons en automne 1993 ont été obtenues en aquarium. Seules, *in situ*, des manifestations extérieures de la plante liées à la floraison ont été observées. En août 1988, nous avons récolté à 30 m de profondeur dans la baie de Galéria (Corse, France) des boutures orthotropes à un faisceau foliaire destinées à l'étude de l'incidence du déplacement bathymétrique; 14 % de ces boutures portaient un reste de hampe florale correspondant à la floraison de l'automne précédent (automne 1987). Pour les expériences de transplantation, nous n'avons sélectionné que les boutures ne portant pas de reste d'inflorescence. En février 1989, six mois après la transplantation, la présence d'inflorescences brunâtres sur certaines boutures témoignait de la floraison de ces boutures à l'automne 1988. Les taux de floraison obtenus aux différentes profondeurs de transplantation sont présentés dans le tableau I.

Tableau I : Taux de floraison de boutures orthotropes à un faisceau foliaire de *Posidonia oceanica* récoltées à 30 m de profondeur et transplantées à 3 m, 14 m, 20 m et 36 m de profondeur.

Profondeur de transplantation	3 m	14 m	20 m	36 m
Taux de floraison des boutures	33 %	21 %	0 %	0 %

Ces résultats montrent que les taux de floraison des boutures transplantées à 3 et 14 m sont plus élevés que le taux de floraison de l'année précédente de l'herbier à 30 m de profondeur dont elles proviennent et qui étaient de 14%. Ainsi, la transplantation de boutures provenant d'un clone apte fleurir peut induire la floraison lorsque cette transplantation est faite à des profondeurs plus faibles que la profondeur d'origine. Ces observations préliminaires nous ont conduit à réaliser une expérience répétée sur plusieurs mois avant la période de floraison, afin de déterminer le mois le plus favorable à son induction. Dans les deux sites d'étude : Réserve Naturelle des Lavezzi au sud de la Corse et baie de Galéria au nord-ouest dans le Parc Naturel Régional de la Corse, toutes les boutures ont été transplantées à une profondeur inférieure à leur profondeur de récolte. Pour l'expérience réalisée dans la Réserve Naturelle des Lavezzi, nous avons prélevé en début de mois d'avril, mai, juin et juillet 1990 des lots de 50 boutures dans un herbier à 5 m de profondeur présentant en automne 1989 un taux de floraison de 50%. Les boutures ont été sélectionnées de telle sorte qu'elles ne portaient pas de reste de floraison des dix dernières années. Les boutures témoins (lot de 50) ont été récoltées dans une petite tache d'herbier qui n'a pas fleuri en automne 1989. Les boutures ont été transplantées à une profondeur inférieure (2 m) à leur profondeur de récolte (5 m) dans un herbier vivant clairsemé. Le contrôle des boutures en décembre 1990 a montré qu'aucune bouture transplantée n'avait fleuri durant l'automne suivant leur transplantation. Dans l'herbier de récolte, seulement deux fleurs ont été trouvées à la même date pour une surface d'environ 100 m^2. Dans ce secteur de la Méditerranée, il semble que les facteurs physiques et climatologiques nécessaires à l'induction de la floraison n'aient pas été réunis pendant l'année 1990.

Dans la baie de Galéria, durant la première semaine des mois d'avril, mai, juin, juillet et août 1990, nous avons récolté 50 boutures orthotropes à un faisceau foliaire, à 30 m de profondeur dans un herbier présentant un taux de floraison de 29% en automne 1989. Là aussi, les boutures sélectionnées ne portaient pas de reste d'inflorescence depuis au moins dix ans. Un lot de 50 boutures témoins a également été prélevé dans un herbier à 30 m de profondeur n'ayant pas fleuri depuis au moins dix ans. Toutes les boutures ont été transplantées à 14 m de profondeur sur un substrat de matte morte. En décembre 1990, les boutures témoins n'avaient pas fleuri alors qu'au contraire, celles provenant de l'herbier à 30 m de profondeur susceptible de fleurir présentaient des taux de floraison variable en fonction des mois auxquels elles avaient été transplantées. Les résultats sont présentés dans le tableau II.

Tableau II : Taux de floraison de boutures orthotropes à un faisceau foliaire de *Posidonia oceanica* récoltées à 30 m de profondeur et transplantées à 14 m à des différentes dates avant la période de floraison.

Dates de transplantation	avril 90	mai 90	juin 90	juill 90	août 90
Taux de floraison des boutures	0 %	0 %	8 %	9 %	10 %

Lors du contrôle en décembre 1990, nous avons évalué le taux de floraison de l'herbier à 30 m d'où provenaient les boutures. Sachant que la densité de l'herbier, à cette profondeur, est en moyenne de 237 faisceaux foliaires par m^2, dont 8% sont à croissance plagiotrope (non apte à fleurir), et que nous n'avons rencontré que trois inflorescences sur une surface de 100 m^2, cela nous donne un taux de floraison de 0.014 %.

Au nord-ouest comme au sud de la Corse, l'année 1990 n'a donc pas été favorable à l'induction de la floraison. Malgré ce mauvais "millésime" de floraison, le déplacement bathymétrique des boutures a permis une stimulation indiscutable de la floraison dans le site de Galéria. Nos expériences confirment avant tout l'hypothèse de CAYE & MEINESZ (1992) sur l'aptitude de certains clones à fleurir car seules les boutures prélevées dans une zone de floraisons antérieures récentes ont fleuri l'année suivante. Par ailleurs, il semble que la température soit un facteur environnemental ayant pu induire la floraison de nos boutures. En effet, c'est au mois de juin que commence à se former la thermocline, soit une nette différence de température entre l'eau de surface (0 à 15-20 m) et l'eau plus profonde (au-delà de 20 m). Il est donc possible que la variation brutale de température entre 30 m (17°C) et 14 m (20°C en juin 1990 et 24°C en août 1990), dans le site de Galéria, ait stimulé l'induction de la floraison, alors que la différence de température entre 30 m et 14 m n'était pas perceptible en avril et en mai. Pour les expériences réalisées aux Lavezzi, la différence de température entre le site de récolte (5 m) et le site de transplantation (2 m) n'étant pas perceptible quel que soit le mois, la floraison n'a pas été induite.

Les auteurs ayant émis des hypothèses quant au déterminisme de la floraison de *Posidonia oceanica*, font allusion aux températures estivales particulièrement élevées qui favoriseraient la floraison et aux températures hivernales clémentes, sans tenir compte de la profondeur. Certes, la température n'est pas le seul facteur ayant pu avoir un effet sur ces floraisons, d'autres facteurs tels les modifications de l'exposition à la lumière entre le site de prélèvement et le site de transplantation peuvent aussi avoir une influence.

OBSERVATIONS ON CORAL FISHING (*CORALLIUM RUBRUM* L.) IN WESTERN SARDINIA

M. MURENU, D. CUCCU, C. FOLLESA, A. SABATINI and A.CAU

Dip. Biologia Animale ed Ecologia, V.le Poetto,1, Cagliari, Italia

In the last ten years the number of permits issued by the Autonomous Region of Sardinia for the fishing of red coral (*Corallium rubrum*) has gone from 77 in 1983 to 17 in 1993. This is most probably due to the fact that the amounts of coral fished have decreased year by year. This decrease, which was initially balanced by the increase in unit price, later led to a decrease of approximately 78% in the number of persons involved in this activity. The immediate consequence of this has been the adoption by regional authorities of measures limiting the use of certain kinds of equipment and the number of licences granted (Regional Presidential Decree n°59 & foll., dated 5 July 1979).

In the light of the economic and biological importance of this coral species, a survey was performed to establish the state of stocks of *C. rubrum* about which very little information was available, prior to the coming into force of the above-mentioned decree (BARLETTA *et al.*, 1968; BARLETTA & VIGHI, 1968). Biological material was collected at depths between 70 and 100 meters off the central western coast of Sardinia (Fig. 1).

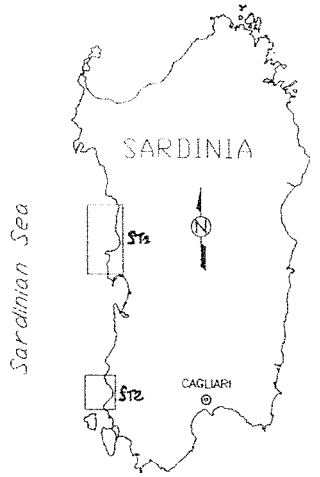


Fig. 1 Map of the studied zone.

Parameters measured on over 150 colonies were : width of the axis, height and weight.

Tab. 1 - Diameter (ø) - Height (h) - Weight (W) mean and relative Standard Deviations (s.d.) in samples of Mediterranean *Corallium rubrum* L.

LOCALITY	ø ± sd< (mm)	h±sd (cm)	Wt (g)	Depth min. max.	References
Corsica	12±3.4	10±2.8	35±28	70 - 90	Marin & Reynald, 1981
Bastia	12±3.8	12±3.9	56±53	70 - 90	Marin & Reynald, 1981
Carloforte	10.0±2.6	8.9±1.3	24±17	70 - 100	(present report)
Oristano	12.7±4.3	0.5±3.7	46.0±41.3	70 - 90	(present report)
Majorca	13.7	11.9	118.9	70 - 90	Garcia-Rodriguez & Masso, 1986

Of the parameters measured, in agreement with Garcia-Rodriguez, diameter at the base is undoubtedly the most significant. In the comparison of the mean diameter of samples taken at Oristano (Station 1) with those taken in analogous areas of Corsica, no significant differences emerge. Values of this parameter are higher than at Station 2 and lower than those of Majorca (Table 1).

The differences found are, in all probability and as supposed by MARIN and REYNALD (1981), attributable to the different intensity of exploitation practised on the populations. However, mean diameter values of samples from the colony at Station 1 (12.7 ± 4.3 mm) and at Station 2 (10.0 ± 2.6 mm) are higher than those found by GARCIA-RODRIGUEZ and MASSO (1986) (8.6 ± 0.7 mm) as the minimum level of exploitation and 8.5 mm as the minimum size for collection.

The mean size of diameter at the base of the populations sampled, together with the average amounts fished by a single operator (1.5 - 2 kg/day - present report), would lead to the supposition that coral resources in the areas considered are still in a balanced situation. However, it is to be hoped that a strategy of planned management based on rotation of exploited colonies in the Sardinian areas will prevail in order to protect stocks.

REFERENCES

BARLETTA G., MARCHETTI T. & VIGHI M., 1968. Istituto Lombardo (Rend. Sc.) B 102 : 119-144.

D.P.R. regolamento della pesca del corallo. 5.07.1979, n°59

MARIN J. & REYNAL DE SAINT-MICHEL., 1981. *Rapp. Comm. int. Mer Médit.* , 27, 2 : 171-172

SANTANGELO G. & ABBIATI M., 1989.*Oebalia* , XV-1 : 323-326

CATTANEO-VIETTI R., BARBIERI M., BAVESTRELLO G. & SENES L., 1989. *Nova Thal.*, Suppl. 1,10 : 575-578

CATTANEO-VIETTI R., BAVESTRELLO G. & SENES L., 1992. *Biologia Marina Suppl. Notiz.* S.I.B.M., 1 : 281-284

GARCIA-RODRIGUEZ M., MASSO C., 1986. *Bol. Inst. Esp. Oceanogr.*, 3, 4 : 61-64

GARCIA-RODRIGUEZ M., MASSO C., 1986. *Bol. Inst. Esp. Oceanogr.*, 3, 4 : 75-82.

B

B

PRELIMINARY STUDY ON THE BIOLOGY OF NORWAY LOBSTER *NEPHROPS NORVEGICUS*, IN THE GULFS OF CHALKIDIKI (GREECE)

MYTILINEOU, CH., FOURTOUNI, A. and C. PAPACONSTANTINOU

National Centre for Marine Research, Ag. Kosmas, 16604 Athens, Greece

Norway lobster is a common decapod in the Atlantic Ocean, the North and the Mediterranean seas. Despite numerous studies, a lot of questions, most of them related with age and growth, still remain open for research. Preliminary studies have been done on the biology of the species in the Greek waters (MYTILINEOU *et al.*, 1992, 1993). This work provides more information about the size composition, the age, the growth, the depth distribution and the reproduction of norway lobster in the northern part of the Aegean Sea. Samples were collected at three months intervals, from June 1992 to September 1993, with a commercial trawler equipped with a cod-end mesh size of 32 mm in the two gulfs of Chalkidiki, situated in the nothern part of the Aegean Sea. A total of 3861 individuals was caught during all sampling periods. Carapace length, weight, sex, maturity stages of females and berried females were recorded. All analyses have been made separately for each sex. Age was determined from the length-frequency distributions using Bhattacharya's (1967) method, as applied in the Compleat Elefan (GAYANILO *et al.*, 1988). Growth parameters Loo and k were estimated using Compleat Elefan. The length-frequency diagrams of norway lobster showed that carapace length ranged from 16 to 73 mm for males and from 12 to 53 mm for females (Fig. 1). Young of the year appeared as recruits mainly in March, but they were present in the trawl net until June. The length - frequency distribution of each sample was analyzed for the identification of the normal components corresponding to the age groups. Five age groups were detected for both sexes. As an example, the results of the analysis of the June 1993 sample are presented in Table 1.

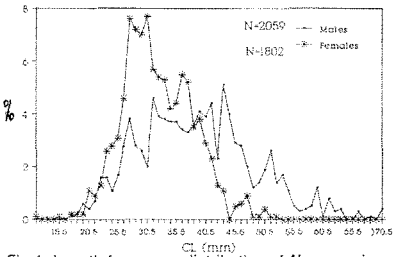


Fig.1. Length frequency distribution of *N. norvegicus* for each sex.

Table 1. Age groups of *N. norvegicus* identified by the Bhattacharya's method

Age group	MALES Mean length	SI	SD	FEMALES Mean length	SI	SD
A	24.6	-	0.9	21.5	-	2.2
B	28.4	4.7	0.8	26.2	2.7	1.3
C	32.0	4.7	0.7	29.8	2.9	1.2
D	35.4	4.4	0.9	33.9	3.6	1.1
E	37.7	2.3	1.1	36.7	2.5	1.1

SI : separation index, SD : standard deviation

Certainly, more age groups might exist beyond the upper and lower limit of the identified lengths-at-age. Polymodal analysis was not able to detect well the age groups of the larger individuals (> 40 mm) because of their low percentage in the samples as well as because of their low growth rate that produces overlap between the different age groups. Moreover, the age groups of the young individuals (< 20 mm) was difficult to be identified because of the gear selectivity that influences the representativity of them in the samples. For this reason, the age groups identified by length-based methods should be considerd with caution. The growth parameters of the von Bertalanffy model, estimated by the Compleat Elefan, were found to be as follows : Loo = 82.6 mm, k = 0.11 for males and Loo = 65.6, k = 0.127 for fe-males. The carapace length-weight relationship was calculated as follows : W = 0.000353L3.138 , r = 0.90 for males and W = 0.000523L3.o54, r = 0.98 for females. Norway lobster in the gulfs of Chalkidiki was caught, during all the sampling periods, at depths ranging from 150 to 370 m; its maximum presence was found in waters >200 m. Examination of the number of individuals caught per hour presented seasonal fluctuations ranging from a high of about 200/h in December to a low of 20-40/h in June '92 and 50-60/h in June '93. This despite the fact that December is a period open for trawl fishing whereas in June trawl fishing is not permitted. The proportion of male and female remained generally about 1:1. However, females were less abundant than males in the March and September samples, fact related to the behaviour of female norway lobsters, which pass a long period hidden in the burrows during moulting (March) and spawning (September). As shown in figure 2, mature females appeared mainly in June. Berried females were found mainly in September and December. and few of them in March. The minimum length of mature females was 25 mm and the L50 was found 34 mm.

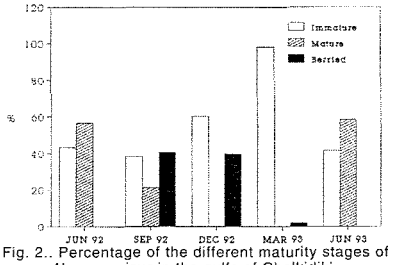


Fig. 2.. Percentage of the different maturity stages of *N. norvegicus* in the gulfs of Chalkidiki.

REFERENCES

BHATTACHARYA, C.G., 1967. *Biometrics*, 23 : 115-135.

GAYANILO, F.C., SORIANO J.M. and D. PAULY, 1988. ICLARM, Software 2, 66p.

MYTILINEOU, CH., FOURTOUNI A. and C. PAPACONSTANTINOU, 1992. *Rapp. Comm. int. mer Médit.*, 33 : 46.

MYTILINEOU, CH., C. PAPACONSTANTINOU & A. FOURTOUNI, 1993. Bios, vol 1, n° 1 : 117-126;

LE PEUPLEMENT ALGAL AU VOISINAGE DE LA CENTRALE THERMIQUE DE MERS-EL-HADJADJ (GOLFE D'ARZEW, OUEST ALGÉRIEN) : AFFINITÉS BIOGÉOGRAPHIQUES

N. OULD-AHMED[1], N. BOUNAGA[2], S. CIRIK[3]

[1] Inst. des Sciences de la Mer et de l'Aménagement du Littoral, BP 54 ,W. Tipaza, Algérie
[2] BP 119 Alger Gare, 16000, Alger, Algérie
[3] Deniz Bilimeri ve-Teknolojisi enstü su, 478 Izmir, Turquie

L'étude de la composition floristique algale et son analyse biogéographique près de la centrale thermique (804 MW) de Mers-El-Hadjadj ont mis en évidence d'importantes variations dans la distribution des peuplements entre la prise d'eau et le voisinage immédiat du rejet thermique. L'échantillonnage est effectué sur un cycle saisonnier à des profondeurs comprises entre 0 et - 0,50 m. La surface échantillonnée est de 25x25 cm, selon la méthode de BOUDOURESQUE (1971). Le site de prise d'eau est considéré comme site de référence. Un Δt de 7 à 8°C est enregistré entre la prise d'eau et le site immédiatement influencé par le rejet thermique. Une concentration en chlore de 0,5 ppm est notée près du rejet. Les résultats obtenus (fig.1) montrent l'existence d'un peuplement dominé par des espèces à affinités chaudes près du rejet thermique.

De ce fait, nous obtenons des dominances qualitatives élevées de l'élément Pantropical. Les espèces le constituant sont généralement des Rhodophytes : *Ceramium gracillimum, Ceramium tenerrimum, Crouania attenuata, Gymnothamniom elegans, Herposiphonia secunda, Herposiphonia tenella, Hypnea musciformis, Gelidium pusillum* et une petite Fucophyceae : *Sphacelaria tribuloides*. Ce sont, en général, des espèces photophiles de l'infralittoral (BOUDOURESQUE, 1984). Nous avons un second peuplement constitué d'espèces dites "eurythermes et euryhalines à Faciès thermophile" (VERLAQUE, 1977) dominé par *Gelidium spathulatum* et *Gelidium melanoideum*. Les espèces atlantico-tropicales sont généralement mieux représentées dans le site de rejet qu'à la prise d'eau, notamment : *Cladophora prolifera* et *Valonia utricularis*. Le site de rejet est également riche qualitativement en espèces cosmopolites, telles *Ulva rigida, Enteromorpha intestinalis, Chaetomorpha aerea* et *Goniotrichum alsidii*. Des espèces méditerranéennes sont observées dans le site de rejet avec une dominance qualitative maximale obtenue en fin d'automne. Parmi elles : *Corallina granifera, Cladophora dalmatica* et *Cladophora coelothrix*. Signalons la rareté, voire la disparition, des espèces à affinités froides ou tempérées dans le site de rejet. Les espèces appartenant à l'élément boréal n'y existent qu'en hiver, avec comme exemple : *Antithamnion cruciatum*. Les espèces de l'élément atlantique boréal telles *Corallina elongata, Callithamnion granulatum, Ceramium ciliatum* y sont absentes en été. L'élément atlantique-intermédiaire est représenté par une seule espèce, présente en été et au printemps : *Colpomenia sinuosa*, espèce indicatrice de "pollution". A la prise d'eau, le peuplement est qualitativement dominé par des espèces à affinités froides ou tempérées, par exemple : *Ceramium ciliatum, Ceramium echinotum, Corallina elongata, Callithamnion granulatum, Griffithsia flosculosa, Polysiphonia sertularioides, Cladophora albida, Dilophus spiralis, Ectocarpus siliculosus* qui est souvent épiphyte sur *Cystoseira tamariscifolia, Laurencia pinnatifida, Chaetomorpha capillaris*, indicatrice de "pollution", *Padina pavonica* et *Taonia atomaria*. L'élément boréal est mieux représenté qualitativement en hiver et en fin d'automne, avec : *Antithamnion cruciatum, Ceramium rubrum, Cladophora rupestris, Cladophora laetevirens* et la Fucophyceae *Aglaozonia parvula*. Les espèces atlantico-intermédiaires présentes à la prise d'eau sont dominantes qualitativement en été et rares au printemps, avec : *Polysiphonia opaca, Pterosiphonia pennata, Peyssonnelia squamaria* et *Dilophus fasciolata*. En revanche, les espèces d'eaux chaudes, en particulier celles appartenant à l'élément atlantique-tropical, ont disparu à la prise d'eau en hiver et en fin d'automne. Pendant les saisons chaudes (été et printemps), leurs dominances qualitatives restent faibles. Les espèces pantropicales, dominantes dans tout le site, sont relativement moins bien représentées à la prise d'eau que dans le site de rejet. De même pour l'élément méditerranéen qui domine qualitativement en fin d'automne avec : *Antithamnion elegans, Polysiphonia mottei, Polysiphonia sertularioides, Corallina granifera* et *Cystoseira crinita, Cladophora coelothrix, Cladophora dalmatica* et *Bryopsis muscosa*.

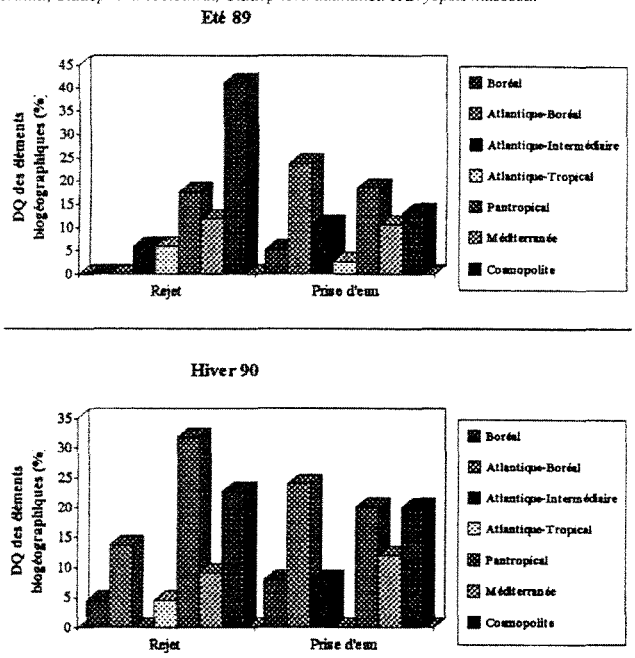


Fig.1: Dominance qualitative des différents éléments biogéographiques au niveau du site de rejet et du site de prise d'eau, en été et en hiver

RÉFÉRENCES

BOUDOURESQUE C.F., 1971. Méthodes d'étude qualitative et quantitative du benthos (en particulier du phytobenthos). *Téthys*, Fr.,3(1) : 79-104.

BOUDOURESQUE C.F., 1984. Groupes écologiques d'algues marines en Méditerranée nord-occidentale. *Gior. Bot. Ital.*, 118 (suppl.2) : 7-42

VERLAQUE M., 1977. Étude du peuplement phytobenthique au voisinage de la centrale thermique de Martigue-Ponteau (Golfe de Fos, France). Thèse de 3e cycle Univ. d'Aix-Marseille II, 172 pp.

MICROSTRUCTURE DE L'HERBIER À *POSIDONIA OCEANICA* DE LA BAIE DE CALVI (CORSE)

Gérard PERGENT, Jean Christophe BARBIER, Christine PERGENT-MARTINI, Madeleine SOULLARD

EP CNRS J0075, Ecosystèmes Littoraux, Univ. de Corse, BP 52, 20250 Corte, France

L'hétérogénéité de l'herbier à *Posidonia oceanica* est un phénomène connu depuis plusieurs années (PANAYOTIDIS *et al.*, 1981). Ces discontinuités, souvent désignées sous le terme de *patchiness* sont, en revanche, difficiles à cerner au niveau spatial par les méthodes d'études classiques (cartographies, biocénotiques, transects, phénologie....). Aussi l'utilisation de techniques d'interpolations stochastiques, et plus particulièrement le krigeage, semblent tout particulièrement indiquées pour réaliser une approche de la structure fine de l'herbier (SCARDI *et al.*, 1989; PERGENT, 1990). Une étude précise de la microstructure de l'herbier à *Posidonia oceanica*, par krigeage, a été entreprise, au mois de mai, dans la Baie de Calvi (Corse), à proximité de la station de recherche océanographique de STARESO, dans 86 stations réparties sur une surface de 4 hectares. Les paramètres pris en compte pour cette étude sont : la profondeur (profondimètre électronique MDS de Beuchat), la densité de l'herbier = nombre de faisceaux par m² (5 comptages), et la longueur maximale des feuilles (prélèvement de 10 faisceaux). Le calcul de l'algorithme du krigeage a été réalisé à l'aide du logiciel "Surfer" édité par Golden Software. Les informations récoltées sur le terrain sont les composantes de la fonction d'interpolation gérées par le logiciel afin d'obtenir des lignes d'égale intensité d'un paramètre. La carte d'iso-densité de l'herbier met en évidence une réduction significative de la densité pour des profondeurs croissantes (Figure 1; r = -0.90). Ces mesures confirment des observations ponctuelles réalisées par de nombreux auteurs (PERGENT & PERGENT-MARTINI, 1988). Toutefois, surimposées à cette tendance générale, des variations beaucoup plus limitées au niveau spatial apparaissent; ces phénomènes présentent une ampleur d'autant plus forte que l'on se situe dans la partie superficielle de l'herbier (Figure 1).

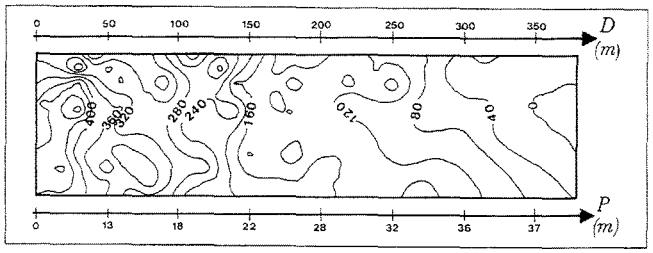


Fig. 1 : Densité de l'herbier (nombre de faisceaux par m²) en fonction de la distance à la côte et de la profondeur.

A cette période de l'année (printemps) où la croissance des nouvelles feuilles dans le faisceau est importante (BAY, 1984), la longueur maximale des feuilles suit un modèle similaire à la densité de l'herbier; elle est d'autant plus faible que la profondeur augmente (Figure 2; r = -0.66). Là encore, une plus grande variabilité apparaît à faible profondeur (0 à -15 m). Toutefois, ces variations ne semblent pas aléatoires : une corrélation significative entre la densité de l'herbier et la longueur maximale des feuilles est mise en évidence pour des tranches bathymétriques homogènes.

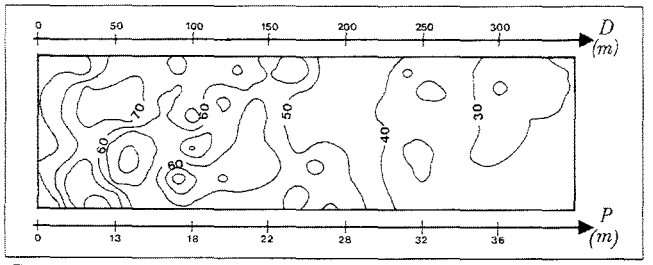


Fig.2 : Longueur maximale des feuilles (en cm) en fonction de la distance à la côte et de la profondeur.

Les discontinuités "cartographiées" ici par la méthode de krigeage confirment l'existence d'une hétérogénéité dans la microstructure de l'herbier (e.g. densité); cette hétérogénéité apparaît plus élevée dans les stations superficielles qu'en profondeur où les conditions du milieu sont plus homogènes. L'origine de ce phénomène est complexe, il peut être imputé à :

(i) La superposition de clones d'origine et d'âge différents au sein d'un même herbier,

(ii) La nature du substrat (mosaïque de fonds rocheux et de fonds meubles),

(iii) La concentration en nutriments du sédiment (POWELL *et al.*, 1989).

L'existence d'une corrélation significative entre la longueur maximale des feuilles et la densité de l'herbier est tout à fait intéressante dans le sens où l'on peut comparer ce phénomène à une forme de compétition. En effet, les feuilles les plus grandes se situent dans les touffes les plus denses et traduiraient donc un phénomène de compétition intra-spécifique vis-à-vis de la lumière. Toutefois d'autres paramètres peuvent expliquer tout au moins en partie ce phénomène : concentration en nutriments (N et P), impact des herbivores, cycle végétatif de la plante,....

REMERCIEMENTS. Cette étude a été réalisée en collaboration avec la station de STARESO et le laboratoire d'Océanographie de l'Université de Liège dans le cadre du programme STEP C0063 de la Commission des Communautés Européennes.

RÉFÉRENCES

BAY D., 1984. A field study of the growth dynamics and productivity of *Posidonia oceanica* (L.) Delile in Calvi Bay, Corsica. *Aquat. Bot.*, 20 : 43-64.

PANAYOTIDIS P., BOUDOURESQUE C.F., MARCOT-COQUEUGNIOT J., 1981. Microstructure de l'herbier de *Posidonia oceanica* (Linnaeus) Delile. *Botanica marina*, 24 (3) : 115-124.

PERGENT G., 1990. Utilisation de la technique du krigeage en cartographie benthique : intérêt et limites. *Rapp. Com. inter. mer Médit.*, Monaco, 32(1) B-I8 : 6.

PERGENT G., PERGENT-MARTINI C., 1988. Phénologie de *Posidonia oceanica* (Linnaeus) Delile dans le bassin méditerranéen. *Ann. Inst. océanogr.*, 64(2) : 79-100.

POWELL G.V.N., KENWORTHY W.J., FOURQUEREAN J.W., 1989. Experimental evidence for nutrient limitation of seagrass growth in a tropical estuary with restricted circulation. *Bull. Mar. Sci.*, 44 : 324-340.

SCARDI M., FRESI E., ARDIZZONE G.D., 1989. Cartographic representation of sea-grass beds : Application of a stochastic interpolation technique (Kriging). International Workshop on *Posidonia* Beds, Boudouresque C.F., Meinesz A., Fresi E. & Gravez V. edit., GIS Posidonie publ., 2 : 19-27.

BIOCHEMICAL GENETICS OF THE PINK PRAWN, *ARISTEUS ANTENNATUS* RISSO, IN THE WESTERN MEDITERRANEAN

C. PLA, M. I. ROLDÁN & J.L. GARCÍA-MARÍN

Lab. d'Ictiologia genètica. Fac. de Ciències Experimentals, Univ. de Girona, Spain

Aristeus antennatus is one of the most important crustacea species in the Western Mediterranean as regards its commercial value. It supports important fisheries in this area as well as many on the Portuguese coast of the Atlantic Ocean (SARDÁ & DEMESTRE, 1987). Despite this, this species has not been studied in depth and most papers are about the fishery problems (BAS, 1960, MASSUTÍ & DAROCA, 1978; MAURIN, 1965). In the late 1980's, several studies were carried out on the pink prawn with the aim of elucidating the reason for the spatial-temporal fluctuations of its populations (RELINI & SEMERIA, 1982; ARROBAS & RIBEIRO, 1984; SARDÁ & DEMESTRE, 1985, 1987). This paper shows the first, and preliminary, biochemical data of *Aristeus antennatus* in the Western Mediterranean and it dovetails with a study that was initiated to correlationate biometric and genetic data with the aim of checking differences between local populations of an area. We studied three different populations : Sant Carles de la Ràpita and Alicante (in the Northeastern Spanish Mediterranean coast) and Palma de Mallorca (in the Balearic Island). For each sample, 30 individuals were analyzed by electrophoresis according to the method of AEBERSOLD *et al.* (1987). Table 1 shows details of enzyme systems analyzed, of sampled tissue used and of electrophoretic running conditions. We have used the terminolgy of SHAKLEE *et al.* (1990) to make the description of enzyme systems and isozyme loci. Of 27 enzyme systems studied, 4 showed no activity and 14 showed a bad resolution. Of the rest, 11 loci were monomorphic and 4 polymorphic (GPI*, IDHP*, MDH-2* and PGM*) in all three populations. Of these, only GPI* and PGM* were polimorphic at 5% level. Electromorph frequencies at both polymorphic loci are presented in Table 2. Heterogeneity X^2 tests were conducted on these two polimorphic loci for all three populations. Analysis results were not significant in either of the loci (GPI*, X^2=2,71, df=4; PGM*, X^2=9,31, df=4).

REFERENCES

AEBERSOLD, P., G. WINANS, D.TEEL, G. MILNER & F. UTTER. 1987. Manual for starch gel electrophoresis: A method for detection of genetic variation. NOAA Tech. Report NMFS 61.

ARROBAS, I & A. RIBEIRO. 1984. New contribution to the knowledge about biology and fishery of *Aristeus antennatus* (Risso,1816) of South Portuguese cost. ICES, Shellfish Cmte., CM1984/K:52, 14 pp.

BAS, C. 1960. Variaciones de la pesca de crustáceos de fondo. IV Reunión sobre Productividad y Pesca. Inst. Invest. Pesq.: 91-94.

MAURIN, Cl. 1965. Répartition des crevettes profondes au large des côtes de Sardaigne et de Corse. *Rapp. Comm. int. Mer Médit.*, 18(2) : 175-178.

MASSUTÍ, M. & E. DAROCA. 1978. Introducción al estudio de la biología de la gamba *Aristeus antennatus* de las pesquerias del sur de Mallorca. Trab. Comp. Dep. de Pesca, (IEO) : 264-277.

RELINI ORSI, L. & M. SEMERIA. 1982. Oogenesi and reproductive strategies in bathyal Penaeid prawns, *Aristeus antennatus* and *Aristeomorpha foliacea*. *Rapp. Comm. int. Mer Médit.*, 28(3): 2pp.

SARDÁ, F. & M. DEMESTRE. 1985. Determination of the intermoult stages in *Aristeus antennatus* Rissso 1816 by setal development. *Rapp. Comm. int. Mer Médit.*, 29(5) : 305-307.

SARDÁ, F. & M. DEMESTRE. 1987. Estudio biológico de la gamba *Aristeus antennatus* (Risso, 1816) en el Mar Catalán (NE de España). *Inv. Pesq.*, 51(1) : 213-232.

SHAKLEE, J.; F. ALLENDORF; D. MORIZOT & G. WHITT. 1990. Gene Nomenclature for Protein-Coding Loci in Fish. *Trans. of Ame. Fish. Socy.*, 119 : 2-15.

Support to this work was provided by a grant of the Institut d'Estudis Catalans (Catalonia, Spain) to C. Bas coordinator of the project : "Spatial and temporal fluctuations of the pink prawn (*Aristeus antennatus* Risso) in the Western Mediterranean".

Table 1. Enzyme systems analyzed in muscle (M) and hepato-pancreas (H) of *Aristeus antennatus*.. Buffers: TC/LB(1); ACT (2); Poulik (3); TBE+NAD (4). Resolution: na=no activity; br= bad resolution; m=monomorphic; p=polymorfic (the number indicates number of alleles).

Enzyme	Number	Locus	Resolution	Buffer	Tissue
Aspartate aminotransferase	E.C. 2.6.1.1	AAT*	na	1	H
Acid phosphatase	E.C. 3.1.3.2	ACP*	m	1	H
Alcohol dehydrogenase	E.C. 1.1.1.1	ADH*	m	1	M
Creatine kinase	E.C. 2.7.3.2	CK*	m	1	M
Diaphorase	E.C. 1.6.4.3	DIA*	br	1	H
Esterase	E.C. 3.1.1.-	EST*	p (br)	1,3	M, H
Fumarate hydratase	E.C. 4.2.1.2	FH*	br	1,4	M
Glutamatedehydrogenase	E.C. 1.4.1.2	GLUDH*	m	1	M
Glyceraldehyde-3-phosphate dehydrogenase	E.C. 1.2.1.12	GAPDH*	br	4	M
Glycerol-3-phosphate dehydrogenase	E.C. 1.1.1.8	G3PDH*	m	1,4	M
Glucose-6-phosphate isomerase	E.C. 5.3.1.9	GPI*	p (3)	2,3	M
b-Glucuronidase	E.C. 3.2.1.31	bGUS-1*	p (br)	1	H
		bGUS-2*	p (br)	1	H
L-Iditol dehydrogenase	E.C. 1.1.1.14	IDDH*	br	1	M
			na	1	H
Isocitrate dehydrogenase	E.C. 1.1.1.42	IDHP-1*	p (3)	2	M
		IDHP-2*	m	2	M
L-Lactate dehydrogenase	E.C. 1.1.1.27	LDH*	br	2,3	M
Lactoylglutathione lyase	E.C. 4.4.1.5	LGL*	m	1	M
		LGL*	na	1	H
Leucine aminopeptidase	E.C. 3.4.11.1	LAP*	p (br)	1	H
Malate dehydrogenase	E.C. 1.1.1.37	MDH-1*	m	2	M
		MDH-2*	p (2)	2	M
Malic enzyme (NADP+)	E.C. 1.1.1.40	MEP*	m	1	M
		MEP*	br	1	H
Mannose-6-phosphate isomerase	E.C. 5.3.1.8	MPI*	br	3	M
Peptidase-LGG	E.C. 3.4.-.-	PEP-LGG*	br	1	M
Peptidase-LT	E.C. 3.4.-.-	PEP-LT*	p (br)	1	H
Phosphoglucomutase	E.C. 5.4.2.2	PGM*	p (3)	1,2	M
		PGM*	na	1	H
Phosphogluconate dehydrogenase	E.C. 1.1.1.44	PGDH*	m	1	M
Pyruvate kinase	E.C. 2.7.1.40	PK*	p (br)	1	M
Tyrosine aminotransferase	E.C. 2.6.1.5	TAT*	m	4	M
Xanthine oxidase	E.C. 1.2.3.2	XO*	br	1	M

Table 2. Allelic frequencies of GPI* and PGM* loci in the three sampled populations. N = size of the sample.

Allele	Samples		
GPI*	Sant Carles	Alicante	Palma
90	0,367	0,433	0,400
100	0,633	0,550	0,600
120	0,000	0,017	0,000
N	30	30	30
PGM*			
95	0,017	0,133	0,050
100	0,917	0,733	0,867
105	0,066	0,133	0,083
N	30	30	30

B

B

1993 *RAPANA THOMASIANA* STOCK ASSESSMENT AND CATCH PROJECTION ALONG BULGARIAN BLACK SEA COAST

Kamen PRODANOV, Tsenka KONSULOVA

Marine Biology/Ecology Department, Institute of Oceanology, Varna, Bulgaria

The carnivorous sea snail *Rapana thomasiana* Grosse (Gastropoda) immigrated in Black Sea during the early forties, from the Japan Sea. Registered for the first time in Novorosiysk Bay in 1946 it spread along the Caucasian coast, Crimea, North-Western Black Sea, Bulgarian coast (1956) and Turkey (1959) (KONSULOVA, 1992). The investigation along Bulgarian Black Sea coast in 1976 established that the mussel (*Mytilus galloprovincialis* Lam.) abundance has undergone about 10 fold reduction, the main reason being the *Rapana* invasion together with the oxygen deficiency at the bottom water layers in the "post blooming" periods. According the latest investigations from 1984 *Rapana thomasiana* inhabits mainly the shallow zone (up to 20 m depth) and has average shell length of 71.1 mm. The decrease of the predator press with depth results in a progressive restoration of the mussel populations. During last 4 years *Rapana* became an object of commercial exploitation. The threat of overcatch necessitates the accomplishment of stock assessments and catch projections of *Rapana thomasiana*.

According to the 1992 experience from scuba diving catching of the *Rapana*, ten regions for investigation were selected (Table 1).

No	Region Name	Area Km^2	Points
1	Kaliakra	4.56	15
2	Baltchik	101.71	60
3	Aladja	27.66	35
4	Euxinograd	7.77	27
5	Galata	13.21	33
6	Kamtchia	2.07	12
7	Shcorpilovtsi	7.83	26
8	Byala	12.16	20
9	Nesebar	7.44	28
10	Pomorie	30.49	27
	Grand Total	214.90	283

Table 1

The number and the location of the sampling points are chosen so that a representative statistical extract from *Rapana* population is obtained. Stock assessment of *Rapana* is calculated by the square method. The curve of yield per recruitment is estimated by the RICKER's method (1975) :

$$Y/R = F \sum_{tc=3}^{t\lambda=12} Bt\,[\exp(Gt - Zt) - 1]/(Gt - Zt)$$

The optimum value of F ($F_{0.1}$) is estimated by GULLAND and BOEREMA's method (1973). The results of the stock assessment of *Rapana* are given in Table 2.

No	Region Name	Total Biomass [Tons]	Meat/Total weight ratio [%]
1	Kaliakra	27.50	22.58
2	Baltchik	548.07	18.40
3	Aladja	652.04	20.47
4	Euxinograd	35.35	19.69
5	Galata	45.62	20.73
6	Kamtchia	109.95	20.53
7	Shcorpilovtsi	204.94	20.83
8	Byala	154.01	20.10
9	Nesebar	37.24	17.74
10	Pomorie	593.45	17.80
	Grand Total	2408.16	19.89

Table 2

According to yield per recruitment curve (Y/R) Fopt ($F_{0.1}$) is 0.6. Therefore TAC should be 1035.5 tons. The above mentioned figures are lower than the real ones because of the specific hydrological conditions at the time of the investigations (2-16 June 1993), unusually low water temperature. That is why considerably amount of *Rapana* population was still buried in the ground, because of which it could not be accounted. Having in mind the data about catch development during the previous years, a projection could be given that if the investigations were carried out in July or August the commercial stock and TAC would increase with 3500 and 1505 tons respectively (SLABACOV *et al.*, 1993). Besides, the given assessments concern a restricted area of the Bulgarian Black sea coast. If the uninvestigated, but promising regions with total area of 120 sq.km approximately, are taken into consideration, the assessments would increase with 1574.4 and 677 tons respectively. According to the above considerations total prognosis of *Rapana* stock and TAC along Bulgarian Black sea coast during 1993 would-be as follows :

Sources	Commercial stock [Ton]		Allowable catch [ton]	
	Total biomass	Meat biomass	Total	Meat
Observed regions	2408.2	465.4	1035.5	200.1
Not observed regions	1574	313.2	677.0	100.2
Probably buried part of *Rapana* population	3500.0	700.0	1505.0	224.1
Total prognosis	7482.6	1478.6	3217.5	524.4

The commercial stock biomass (individuals with fresh weight above 60 g) and TAC of *Rapana thomasiana* along Bulgarian Black Sea coast during 1993 are about 7482.6 and 3217.5 or 1478.6 and 524.4 tons respectively. The most suitable period of doing such assessments is July.

REFERENCES

GULLAND J.A., BOEREMA L.K. 1973. *Fish. Bull.*, 71 (2), 87 p

KONSULOVA TS.1992. Proceedings of Institute of Oceanology, BAS, Varna v.1 : 103-109

RICKER W.E., 1975. Bull. Fish. Res. Board Can., N° 191, 382 p

SLABACOV CH.*et al.*, 1993. Report of the Institute of Oceanology, Varna.

GROWTH RATE OF *RAPANA THOMASIANA* (GASTROPODA) ALONG BULGARIAN BLACK SEA COAST

Kamen PRODANOV, Tzenka KONSULOVA, Valentina TODOROVA

Department of Marine Biology and Ecology, Institute of Oceanology, Varna, Bulgaria

Rapana thomasiana is introduced into Black sea probably by ships from Japan sea. This far-sea species is now the biggest of the Black sea snails, which predominantly are caracterized with small sizes. More detailed investigations on the life cycle of *Rapana thomasiana* (feeding, growth, age, reproduction) are carried out along the ICC (Ukraine) Black sea coast (ZENKEVICH, 1947; CHUKHCHIN, 1961; IVANOV, RUDENKO, 1969). For the Bulgarian Black sea coast, this species is reported by KANEVA-ABADJIEVA, 1957).

Each sample of *Rapana thomasiana* was separated in size groups according to the shell lenght (the distance from the top of the shell to the end of the siphon channel) at 5 mm interval. The lenght is measured by slide-gauge. After that the following parameters of each size group are measured : total number, total fresh weight (g), total boiled useful meat weight (after 5 minutes boiling), total shell weight (g), age of each speciments. The investigations of growth rate of *Rapana thomasiana* are based on 283 samples from 10 regions and total of 3031 speciments.

The relationship between length and total fresh weight is estimated according the equation :

(1) $W = a.L^n$

Growth parameters of *Rapana thomasiana* are obtained by von Bertalanffy's equations :

(2) $Lt = Linf\ \{ 1 - \exp [- k (t - t_o)] \}$

(3) $Wt = Winf\ \{ 1 - \exp [- k (t - t_o)] \}^n$

where : k = growth coefficient, t = age, Linf and Winf are maximum values of length and weight respectively.

The mean value of natural mortality coefficient is established by the methods of KUTTY, QUASIM (1965), ALVERSON, CARNEY (1975), RICHTER, EFANOV (1976).

(4) $t_c = [\ln (n.k + M) - \ln M] / k + t_o$ Kutty, Quasim

(5) $M = 3.k / [\exp (T_{mb}. k) - 1]$ Alverson, Carney

(6) $M = 1.521 / X^{0.720} - 0.155$ Richter, Efanov

From total investigated area (214.9 sq.km.) the greatest weight and meat density (t/sq.km.) was registered in Kamchia region (19,9 tons), followed by Shkorpilovsti (5.45 tons) and Aladja (5.04 tons) regions. The length and weight compositions varied from 40 to 115 cm. and from 18.39 to 309.58 g. respectively. The mean length and weight values ranged from 70 (Kaliakra region) to 92 cm (Shkorpilovsti) and from 80 to 172 g., respectively.

The parameter values in equation (1) are : a = 0.0005114 n = 2.8135208.

The age composition of *Rapana Thomasina* is given in Table 1

Length	Weight	AGE GROUPS								
[mm]	[g]	2	3	4	5	6	7	8	9	Total
40	18.38		2							2
45	23.24	4	28	10	1					43
50	28.82	4	47	45	5					101
55	35.33	11	44	47	5					107
60	45.61	4	53	46	12					115
65	59.64	4	40	75	34					153
70	75.22	2	34	121	37	16	1			211
75	91.70	1	21	15	96	21	1			255
80	110.35		10	90	183	42	7			332
85	134.80		2	61	176	100	13	1		353
90	159.06			24	155	154	58	6	1	398
95	185.58			9	68	130	94	15	2	318
100	211.59			1	26	88	82	30	2	229
105	242.43				9	21	52	14	1	97
110	272.12				1	9	27	12	4	53
115	309.58						3	5	4	12
Total		30	281	644	808	581	338	83	14	2779
%		1.08	10.11	23.17	29.08	20.91	12.16	2.99	0.50	100.00
Ml		56.67	59.84	70.68	82.86	90.81	97.87	101.40	106.10	
Mg		42.00	50.70	82.70	128.30	165.20	199.80	221.40	262.40	

According to these data, the parameters of Bertalanffy's equations was established:

Linf = 123.98 Winf = 423.75

k = 0.2142202 k = 0.1988782

to = -0.0822087 to = -0.2202925

The values of natural mortality coefficient (M) was estimated by the above mentioned methods (equations 4-6). The mean value is about 0.5.

REFERENCES

ALVERSON D.L., CARNEY M.J., 1975. *J. Cons. int. Explor. Mer*, 36 (2) : 133-143.

CHUKHCHIN V.D., 1961. Proceedings of Biological Institute-Sevastopol, 14 : 163-168 (in Russian).

IVANOV A.I., RUDENKO B.I., 1969. Proceedings of AzCherNIRO, 26 : 167-172 (in Russian).

KANEVA-ABADJIEVA V., 1957. *Fish farming*, 10 : 21-22 (in Bulgarian).

KUTTY M.K., QUASIM G.Z., 1965. *J. Cons. int. Explor. Mer*, 32 (22) : 191-202.

RICHTER V.A., EFANOV V.N. 1976. ICNAF. Res.Doc., VI, pp 8.

ZENKEVICH L.A., 1947. *Nature*, Moskow, 9 : 92-95 (in Russian).

GUT CONTENTS OF THE SEA-URCHIN *PARACENTROTUS LIVIDUS* IN AN IONIAN EMBAYMENT (AMVRAKIKOS GULF – GREECE)

PSARA S., PANCUCCI M.A., PANAYOTIDIS P.

National Centre for Marine Research.16604 Hellinikon, Athens, Greece

There is increasing interest, during last decades, in the study of sea–urchin *Paracentrotus lividus* feeding habits, as the species is one of the most important elements of the hard bottom benthos, often determining the dynamics of marine phytobenthic communities. In the present study *P. lividus* gut contents from two stations of the Amvrakikos Gulf area were examined over three seasonal samplings (4/91, 7/91, 1/92). The two stations were as follows :

a) Station A, located in the Amvrakikos Gulf, a semi-enclosed eutrophic area characterized by an overpopulation of small body–size sea urchins and by lack of macrophytobenthic biomass due to overgrazing (PANCUCCI & PANAYOTIDIS, 1994),

b) Station I, in the Ionian Sea close to the entrance of the Gulf, characterized by oligotrophic conditions (PANAYOTIDIS *et al.*, 1994).

The aim of the study was :

1) to give an estimation of relative abundances of plants, animals and detritus in gut contents,

2) to give a profile of flora and fauna of the examined area as it is reflected in gut content analysis.

Gut content analysis was performed by the method of "Contacts" proposed by JONES (1968) and further developed by NEDELEC (1982).

The results were based on the analyses of 12,000 contacts originated from 60 individual specimens. The analyses concerned four main groups of organisms present : Rhodophyceae, Phaeophyceae, Chlorophyceae and marine Angiosperms. A number of other groups are also reported (blue–green algae, diatoms, dinoflagellates, ciliates, foraminiferans, hydrozoa, sponges, bryozoa and crustaceans).

The two stations appear to be statistically different mainly due to great variations between vegetal and detritus abundances, especially between those of January in St. A and April in St. I. The low vegetal values in the sampling of January are reflecting the unfavorable period for marine vegetation in the study area. The following table resumes the main results.

Stations	St. A			St. I		
	4/91	7/91	1/92	4/91	7/91	1/92
Plants	43.5	34.1	21.6	78.9	65.5	50.6
Animals	1.0	2.8	2.5	5.6	4.0	6.9
Detritus	55.5	63.1	75.9	15.5	30.5	42.5

Thus, *P. lividus* populations living in the Amvrakikos Gulf seem to be adapted to eutrophication conditions, by a detritophagous feeding habit. The hypothesis of changes in the feeding habits could also explain the small body size of the sea urchins, observed in the Amvrakikos Gulf (PANCUCCI *et al.*, 1993).

REFERENCES

NEDELEC H., 1982. Ethologie alimentaire de *Paracentrotus lividus* dans la baie de Galeria (Corse) et son impact sur les peuplements phytobenthiques. Thèse Doct. 3e cycle, Océanographie, Univ. P. et M. Curie, Paris et Univ. Aix–Marseille II, Marseille, Fr.: 1–175.

PANAYOTIDIS P., M.A. PANCUCCI, E. BALOPOULOS & O. GOTSIS–SKRETAS, 1994. Plankton distribution patterns in a Mediterranean dilution basin: Amvrakikos Gulf (Ionian Sea, Greece). *Marine Ecology*, 15 (2).

PANCUCCI M.A., P. PANAYOTIDIS & A. ZENETOS, 1993. Morphological changes in sea–urchin populations as a response to environmental stress. *In* Aldrich, J.C. (ed.) "Quantified Phenotypic Responses in Morphology and Physiology". Proceed. 27th European Marine Biology Symposium, Doublin 1992, JAPAGA, Ashford : 247–257.

PANCUCCI M.A. & P. PANAYOTIDIS, 1994. Impact of eutrophication on sea-urchin populations of the Amvrakikos Gulf (Ionian Sea, Greece). MAP Technical Report Series N 78. UNEP, Athens : 75–90.

VERLAQUE M., 1987. Relations entre *Paracentrotus lividus* (Lamark) et le phytobentos de Méditerranée occidentale. *In* : Boudouresque C.F. (ed) "Colloque Int. sur *Paracentrotus lividus* et les oursins comestibles", Carry–Le–Rouet, Fr.: 5–36.

RECENT OBSERVATIONS ON THE MACROFOULING ON OFFSHORE PLATFORMS AT RAVENNA

RELINI G. and TIXI F.

Laboratori di Biologia Marina ed Ecologia Animale, Università degli Studi di Genova, Istituto di Zoologia, Via Balbi, Genova, Italia

Off the coast at Ravenna there are various gas-drilling platforms positioned at varying distances from the coast and at varying depths. In 1975-76, the macrofouling on two platforms (PCWA and AGO-A) was studied using samples taken from the platform piles and especially by immersing panels in order to determine the settlement patterns of its main components (RELINI *et al.*, 1976).

This paper describes the results obtained using samples taken in 1993 (contract between Univ. Genova and CEOM Palermo) from the PCWA and ANTARES platforms positioned, respectively, at 7 and 10.5 km from the shore and on bottoms at 12 m and 14 m. For each platform a pile was chosen as representative of the macrofouling present on the whole platform. In March and September 1993 samples were obtained by scraping an area of 600 cm^2 using three or four different exposures at the same depth. The levels considered were 0.5, 5.5 and 11 m on the PCWA and 0.5, 7 and 12 m on the ANTARES. By means of photographs and video shots the macrofouling over the whole length of the chosen pile and also those nearby was described. The density, weight and size of the organisms, in particular of the mussels, were determined.

A total of 41 taxa were recognized, of which 35 were species. More than 90% of the taxa were common to both platforms. On the PCWA the macrofouling is characterized by a dominance of mussels up to a depth of around 9-10 m. In the midst of the mussels, or as their epibionts, one finds barnacles, other bivalves, serpulids, hydroids and sea-anemones. Non sessile fauna is represented by brittle stars, flat worms, ribbon worms, amphipods and decapods. Near the bottom mussels disappear and oysters dominate, in particular *Crassostrea gigas*, together with sea-anemones and zoanthid *Epizoanthus arenaceus* (Delle chiaje); the latter cover broad surfaces, at times even higer up, especially when the mussels are eliminated. Also present are : barnacles (*B. trigonus*), hydroids *(Obelia)*, serpulids (*Pomatoceros, Hydroides, Serpula*), which settle both directly on the piles and on other organisms; bryozoans are extremely scarce.

The macrofouling on the ANTARES is very similar both quantitatively and qualitatively speaking. Up to approx. 10-11 m depth mussels dominate accompanied by most of the organisms described in reference to the PCWA. Near the bottom, and only more rarely higher up, one finds large colonies of bryozoan *Schizoporella errata* which contribute to differences in the fouling compared to that found on the PCWA. At this level there are also *Crassostrea gigas*, barnacles, hydroids, serpulids, but *Epizoanthus arenaceus* and sea-anemones are missing.

Using the Kulczynski indices of similarity one finds a greater similarity between the samples obtained at different exposures but at the same depth than between different depths. This last factor (depth) is more discriminative than the seasonal factor. Wet weights show higher values in the samples taken on the surface or at medium depths due to the massive presence of mussels (Table I). There are no large differences in the fouling or mussel weights between the two platforms and the two seasons, even though the highest values were registered in September on the PCWA (- 1 m) with 1558.6 g/dm^2, out of which 1553 g/dm^2 were due to mussels. One can draw the conclusion that over a period of 5-6 months it is possible to reach fouling weights of 155 kg/m^2, which thus exceed the 100 kg found on the one-year panels during the experiment carried out in 1975-76. On the whole there are no substantial differences between the fouling found off Ravenna in 1975-76 and that found in 1993. Thus it is possible to confirm what emerged in 1976 : the macrofouling on the platforms off Ravenna is relatively homogeneous, as it is composed of a small number of species, some of which are represented by a large number of individuals, and up to a depth of 9-10 m it is dominated by mussels, which in the space of only a few months reach extremely high values of density and biomass.

		1993						1975-76		
depth		PCWA fouling		PCWA mussels		ANT. fouling		ANT. mussels		PCWA fouling of panels		
		W	S	W	S	W	S	W	S	6 M Oct	9 M Jan	12 M Apr
0.5 m	Mar	808.3 ± 247.9		791.9 ± 257.9		588.9 ± 220.4		582.7 ± 222.9		586.8	566.8	909.1
	Sep	1147.2 ± 387.1		1142.2 ± 387.7		639.3 ± 212.4		627.6 ± 205.8				
5.5 m	Mar	358.3 ± 41.7		355.9 ± 42.1						256.2	468.4	883.4
	Sep	279.4 ± 137.9		274.9 ± 140.7								
7 m	Mar					756.2 ± 75.5		752.6 ± 75.6				
	Sep					138.9 ± 49.9		111.1 ± 52.3				
11 m	Mar	74 ± 19.5		49.7 ± 28.2						36.2	108.8	202.2
	Sep	45.1 ± 26.9		0.21 ± 0.19								
12 m	Mar					122.3 ± 56.8		10 ± 14.2				
	Sep					118.9 ± 10		30.9 ± 19.4				

Table I: Wet weight of fouling and mussels (g/dm^2).

REFERENCES

RELINI G., GERACI S., MONTANARI M. et ROMAIRONE V., 1972. Variazioni stagionali del fouling sulle piattaforme off-shore di Ravenna e Crotone. *Boll. Pesca Piscic. Idrobiol.*, 31 : 227-256.

B

B

AUTOECOLOGY AND PRODUCTION OF *ZOSTERA MARINA* IN VENICE LAGOON

Andrea RISMONDO[1], Daniele CURIEL[1], Mara MARZOCCHI[1], Carla MICHELI[2]

[1] Dipartimento di Biologia, Università di Padova, Padova Italia
[2] ENEA C.R.E. Analisi e Monitoraggio Ambientale, Roma, Italia

The presence of the three seagrasses *Zostera marina* L., *Zostera noltii* (Hornem.) and *Cymodocea nodosa* (Ucria) Aschers. plays an important role in Venice lagoon ecosystem for trophic balancement, for reducing erosion, improving water clarity, trapping suspended material, producing accumulation of organic and inorganic material. The whole area of the lagoon can be divided into three different hydrological basins with three inlets connecting the lagoon to the Adriatic Sea. The entire lagoon averages about one meter in depth. There are tidal flats which drain almost completely at low tide, islets covered with halophylous vegetation and flooded by the high tide and shallow and deeper canals (ranging from few centimeters to 4-5 m). In the southern basins *Zostera marina* is the most widespread species.

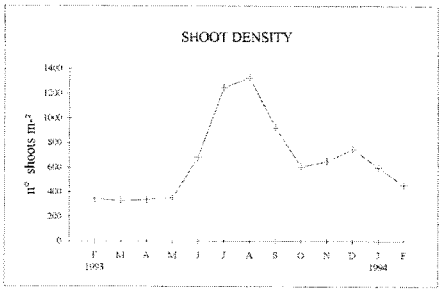
Previous studies concerning autoecology and phenology of *Cymodocea nodosa* in Venice lagoon pointed out the importance of the belowground compartment of the plant and the high values of belowground biomass (rhizoms and roots), in comparison with other mediterranean sites. For this reason a similar research was carried out for *Zostera marina*, considering the importance of this species and its very restricted distribution in Mediterranean Sea. It is also important that, due to pollution and other factors, *Zostera marina* is confined to some areas of the lagoon, with clean water and high current velocities, but in general the lagoon *Zostera marina* beds are not in a satisfactory condition and for this reason this is generally considered an endangered species (DEN HARTOG *et al.*, in press).

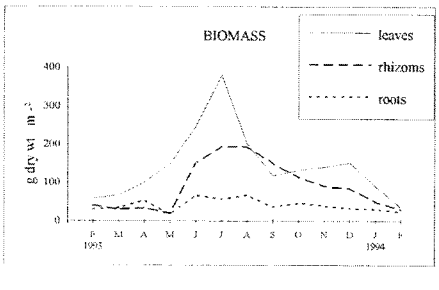
Sampling was carried out monthly from February '93 to February '94, in a pure homogeneous *Zostera marina* stand, close to the central inlet of Malamocco (central lagoon). Shoot density samples were collected by using 40 cm quadrats. Biomass was measured by coring, with a dedicated circular device 25 cm large and 30 cm deep. Following Zieman's method, all the shoots in three quadrats were monthly punched. Plastocronic interval (PI) was also calculated.

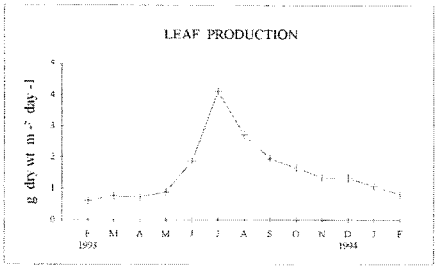
Density values reached a 1,328 shoots.m^{-2} maximum in August and a 330 shoots.m^{-2} minimum in winter time. Total biomass followed a regular trend during the observation year, ranging from February (89 g(d.w.).m^{-2}) to July (630 g(d.w.).m^{-2}. Belowground fraction represented, during almost the whole year, the dominant compartment, reaching always over 50% of the total biomass. Leaf density results positively correlated with LAI (leaf area index), ranging from 0.5 (winter) to summer value between 5 and 7 (7.7. in July). Highest production values were collected in July, with a high 4.1 g(d.w.).m^{-2}.d^{-1}, while in winter time no values under 0.6 g(d.w.).m^{-2}.d^{-1} were collected. The annual set of data showed a regular increasing trend until July and a similar decrease until winter time.

During same period observations, *Zostera marina* did not showed so high density and total biomass values as for *Cymodocea nodosa*. Belowground biomass represents only 40-50 % of the total, while for *Cymodocea nodosa* this datum ranges from 55 to 90%, pointing out the importance of the root apparatus for this species in compacting sediment and preventing erosion. Leaf production is lower for *Zostera marina* than for *Cymodocea nodosa*, but it presents a more regular trend during the year.

Some *Zostera marina* beds in Venice lagoon, far from urban outputs and critic light transmission sites are expanding (SCARTON *et al.*, in press). An estimate of leaf annual production for *Zostera marina*, is 5,500 kg (d.w.) per ha, and 20,000 tons(d.w.) for the entire lagoon.







REFERENCES

CANIGLIA G., BORELLA S., CURIEL D., NASCIMBENI P., PALOSCHI F., RISMONDO A., SCARTON F., TAGLIAPIETRA D., ZANELLA L., 1992. Distribuzione delle fanerogame marine *Zostera marina* L., *Zostera noltii* Hornem, *Cymodocea nodosa* (Ucria) Asch. in Laguna di Venezia. *Lav. Soc. Ven. Sc. Nat.*, 17 : 137-150.

DEN HARTOG C., VERGEER L., RISMONDO A., 1994. Occurence of *Labyrinthula zosterae* in *Zostera marina* from Venice lagoon. *Marine Ecology*, in press.

VERHAGEN J.H.G., NIENHUIS P.H., 1983. A simulation model of production, seasonal changes in biomass and distribution of Eelgrass (*Zostera marina*) in lake Grevelingen. *Mar. Ecol. Prog. Ser.*, 10 : 187-195.

ZIEMAN J.C., 1974. Methods for the study of the growyh and production of turtle grass, *Thalassia testudinum* Koenig. *Aquacolture*, 4 : 139-143.

AUTOTOMY AND INDUCED FRAGMENTATION IN THE RED CORAL (*CORALLIUM RUBRUM* L.)

Giovanni Fulvio RUSSO

Stazione Zoologica "A. Dohrn", Villa Comunale,80121 Napoli, Italia

The red skeletal axis of the mediterranean sea-fan *Corallium rubrum* has been used to make jewellery since prehistoric times, and throughout the centuries, increasingly efficient methods have been devised to harvest natural banks. Today, colonies sufficiently large for jewellery manufacture have become rare and this led to study as how best to manage this marine resource, also taking into account the biology and ecology of the species. Much of our knowledge about the reproductive biology of the red-coral comes from a study conducted over 100 years ago (LACAZE-DUTHIERS, 1864), which describes the classical life cycle of colonial Anthozoans : vegetative growth of the colony branches by asexual replication of polyps, and formation of new colonies from sexually produced larvae. A much more recent study, albeit 20 years old, showed that the red coral has gonochoric larvae and colonies, and a gonadic cycle that is annual for male and biennial for female colonies. During attempts to rear the red-coral in the laboratory (RUSSO *et al.*, 1993), we became aware of a new type of reproductive process, which seems to implicate a reconsideration of the life cycle of the species: the production of new colonies by asexual reproduction and the formation of daughter colonies through the fragmentation of parent colonies by autotomy of branch ends or by deliberate breakage. Records of asexual reproduction of colonies are very rare in Octocorallia. In the sea-fan *Plexaura* sp., localised constrictions in branches facilitates fragmentation by external disturbances (LASKER, 1984). Moreover, endogenous processes of fragmentation are known only for some soft-corals (Alcyonacea) (TURSCH & TURSCH, 1982) and for two species of fan-corals : fragmentation after stolonization in *Briareum asbestinum* (LASKER, 1983), and autotomy of branch ends in *Junceella fragilis*, whereby the coenenchyme is resorbed and the thin, not-living axial core is mechanically broken-off (WALKER & BULL, 1983).

In *Corallium rubrum* the autotomy of branch ends seems to occur with the complete resorption of tissues including the calcareous central axes. The process implies a particular dynamics of calcification which might explain the recently reported higher absorption of Ca in the apical stem (1 cm maximum from the tip) with respect to the remaining part of the colony (ALLEMAND & BENAZET, 1992). Such a specialized mechanism of asexual reproduction as autotomy is the evidence that fragmentation in red-coral is not an accidental consequence of external disturbances, but the result of natural selection with an adaptive meaning. In red-coral colonies, autotomy, occurred after removal from their natural environment to the laboratory and after drastic changes in water temperature and salinity. This indicates that, like in soft-corals (TURSCH & TURSCH, 1982), this asexual process was stress-induced. That is, under adverse conditions, the colonies asexually produce a sufficient number of propagules to ensure population survival. However, the marine environments colonized by red-coral are very stable and are not subject to such drastic changes. Therefore, reproduction by autotomy of branches seems to have a wider ecological meaning than supposed from data obtained in soft-coral. Fragmentation gives rise to colonies that are physiologically distinct but genetically identical ("genets") (HUGES *et al.*, 1992). This is in line with the low genetic variability recently found in *Corallium rubrum* (ABBIATI *et al.*, 1992, 1993). Furthermore, population spreading by short-living planulae and by passive benthonic dispersal of fragments probably enhances philopatry (short-distance dispersal). This kind of life cycle leads to considerable inbreeding, which is promoted by sexual reproduction, and to a high degree of genetic relatedness, which is promoted by fragmentation . Sexual reproduction within inbred lines is the reproductive strategy that best duplicates genotypes over many generations; this is because asexual reproduction faithfully replicates mutants which progressively build up in frequency over time (JACKSON & COATES, 1986). This model predicts that genetic relatedness and intensive inbreeding are extremely favourable for long-living organisms in stable environments, which is likely the case of red-coral. Production of new colonies by mechanical fragmentation, on the other hand, has been reported for many stony-corals (Esacorallia, Scleractiniaria) and seems to be an important mode of reproduction and population stabilization among the main tropical reef- building species. Fragmentation seems to play a major role in the recovery of reefs from recurrent disturbances produced by hurricanes (HIGHSMITH, 1980). Dredging activity for harbour construction, which promotes mechanical fragmentation, also "appears to have no major or lasting effect on the coral diversity and cover" (SHEPPARD, 1980).

Our observations confirm for the red coral what is already well documented for reef building scleractinians: survival and growth of fragments are integral parts of the life cycle of the species and, therefore, are much more than an occasional event. This new reproductive feature should be further studied in order to elucidate a number of biological implications as well as to revaluate the effects of harvesting methods on natural banks. Dredging for red-coral is illegal in most Mediterranean countries because it is considered highly destructive for the bottom communities and scarcely efficient for the harvesting activity. However, because dredging, in which many coral fragments are left on the sea bottom, enhances fragmentation, it could play a not secondary role in the recovery of natural red-coral populations. Red-coral harvesting by scuba divers, on the other hand, is permitted because it is believed to be more efficient and less destructive than dredging (MATÈ, 1984). However, modern diving techniques are so sophisticated as to allow harvesting over almost the entire depth range of the species and, unlike dredging, in cavities. The selective harvesting by divers has a low degree of disturbance for the overall bottom community but, avoiding breakage and loss of commercially valuable parts, could reduce the role of fragmentation in the recovery of red coral population. It is certainly true that the present situation of overexploitation is mostly the effect of an excessive collecting effort in the time, but the attitude of divers to collect all the material available and to avoid leftovers is an aspect of the problem that should not be longer overlooked. An 18th-century Italian prince, believing that red coral colonies were 'zoo-phytes', and thus capable of vegetative reproduction, ordered coral fragments to be scattered over the sea bottom to repopulate the natural banks. Our observations give the first evidence of the effective occurrence of a vegetative reproduction in red coral colonies and therefore the conceptual basis of that early experiment is surprisingly modern.

REFERENCES

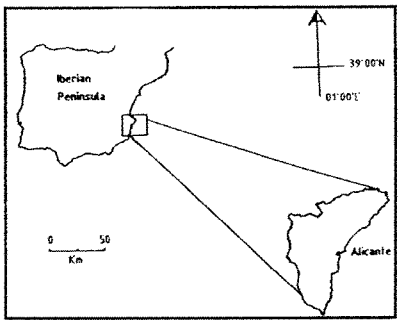
ABBIATI M., SANTANGELO G. & NOVELLI S. 1993. *Mar. Ecol. Progr. Ser.*, 95 : 245-250
ALLEMAND D. & BENAZET S.,1992. *Rapp. Comm. int. Mer Médit.* 33 : 27
HIGHSMITH R. C., 1980. *Mar. Ecol. Progr. Ser.*, 7 : 207-226
HUGES T. P., AYRE D. & CONNEL J. H., 1992. *Trends Ecol. Evol.*, 7 : 292-295
JACKSON J. B. C. & COATES A. G., 1986. *Phil. Trans. R. Soc. Lond.*, B-313 : 7-22
LACAZE-DUTHIERS L. 1864. Histoire naturelle du corail. Baillère, Paris, 370 pp.
LASKER H. R., 1983. *J. Exp. Mar. Biol. Ecol.*, 72 : 157-169
LASKER H. R. 1984. *Mar. Ecol. Progr. Ser.*, 19 : 261-268
MATÈ P., 1984. *FAO Fish. Rep.*, 306: 79-81
RUSSO G.F., ZUPO V., PIRAINO S., ULIANICH L. & CICOGNA F. (1983). *In* : "Red Coral in the Mediterranean Sea : Art, History and Science", F. Cicogna and R. Cattaneo-Vietti (Eds) : 159-179
SHEPPARD C. R. C., 1980. *Mar. Poll. Bull.*. 11 : 227-230
TURSCH B & TURSCH A., 1982. *Marine Biology*, 68 : 321-332
WALKER T. A. & BULL G. D., 1983. *Mar. Ecol. Progr. Ser.*, 12: 137-143

BOTTOM TRAWLING FISHING EFFECTS OVER *POSIDONIA OCEANICA* SEAGRASS MEADOWS AND SEAGRASS-ASSOCIATED FAUNA : PRELIMINARY RESULTS

Pablo SANCHEZ JEREZ [1], Juan E. GUILLEN NIETO[2], David GRASS[2] & Alfonso RAMOS ESPLA[2]

[1] Depart. de Ciencias Ambientales y Recursos Naturales. Univ. de Alicante, Spain
[2] Institut d'Ecologia Litoral. El Campello, Alicante, Spain

Posidonia oceanica is an endemic mediterranean seagrass which is widely distributed along the infralitoral bottoms. It forms extensive meadows with great ecological importance (BOUDOURESQUE & MEINESZ, 1982). One of the most important is its capacity of increasing the habitat complexity in relation to surrounding unvegetated bottoms. In the Iberian Southeast, the bottom trawling fishing affects greatly the *Posidonia* meadows and their associated communities. At the moment, it is not well known the effect of this perturbation on the marine benthos (JONES, 1992). However, many papers have studied the effects of habitat complexity on the tropical seagrass-associates macrofauna community structure. This paper is a preliminary study to look for relationship between changes in the *Posidonia* meadows features and the community structure of seagrass-associated vagil fauna (fish and macroinvertebrates).



Study Site : El Campello (Alicante, SE Spain). The seagrass meadow is irregularly affected from trawl fishing and grown between 1-24 m deep on sand-muddy bottoms.

Sampling was carried out in summer of 1992, in two stations (-16 m deep): an unperturbed and a frequently trawling perturbed station.

- Fish: The fish assemblage was sampled by visual census on 750 m^2. Eight censuses were done in each station (HARMELIN-VIVIEN *et al.*, 1985). The linear coverture of the seagrass meadow was measured on each sample.
- Macroinvertebrate: The crustacean community was sampled by suction bombs in a 0.125 cm^2 quadrat (VADON, 1981). Twelve samples were taken in each station. The shoots density and litter necromass (detritus) were measured on each sample. All the individuals of Decapoda, Amphipoda and Isopoda were identified to species level.

ANOVA was applied to compare the variables between stations. CCA (Canonical Correspondence Analysis) was applied to fauna abundance in relation to features of seagrass meadows (TER BRAAK, 1988).

The figure 1 shows the result of ANOVA for the seagrass meadows features and the total faunal abundance in relation to the two stations. The vegetal litter has increased in the perturbated station, while the unperturbated station has a great coverture. Their changes would take importance over the seagrass-associated fauna.

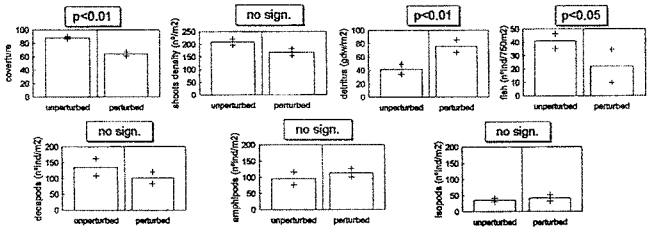


Table 1 shows the correlation between the community structure and the environmental factors. The seagrass meadow's coverture has an important weight over the fish assemblage. Samples from perturbed and unperturbed station are segregated in the ordination diagram. The unperturbed station is related to the "coverture" variable.

TABLE 2	Linear Coverture	
Fish	0.59	
	Shoots density	**Detritus necromass**
Decapoda	0.54	0.64
Amphipoda	ns	0.68
Isopoda	ns	0.6

Decapods, amphipods and isopods are correlated with detritus variable and only decapods are correlated with shoots density. In the ordination diagram, the unperturbed station is associated with the shoots density variable and the perturbed station with the detritus variable. The modification of ecological characteristics of *Posidonia oceanica* seagrass meadows by trawl fishing -reduction of seagrass complexity and increase of litter necromass- could be detected in two ecological scales (fish and macroinvertebrates) by changes on seagrass-associated epifaunal community structure.

REFERENCES

BOUDOURESQUE C.F. & MEINESZ A., 1982. Découverte de l'herbier de posidonie. Cahier Parc Nation. Port-Cros 4 : 79.

HARMELIN-VIVIEN M.L., HARMELIN J.G., CHAUVET C., DUVAL C., GALZIN R., LEJEUNE P., BARNEBE G., BLANC F., CHEVALIER R., DUCLERC J., LASSERE G., 1985. Evaluation visuelles des peuplements et populations de poissons : problèmes et méthodes. *Terre Vie*, 40 : 467-539.

JONES, J.B., 1992. Environmental impact of trawling on the seabed : A rewiew. *N.Z.J. Mar. fresh wat. res.* 26(1) : 59-67.

TER BRAAK C.J.F., 1988. CANOCO. A FORTRAN program for canonical community ordination by (partial) (detrented) (canonical) correspondence analysis, principal components analysis and redundancy analysis (version 2.1). Agricultural Mathematics Group. Wageningen, The Netherlands.

VADON C., 1981. Les Brachyoures des herbiers de Posidonies dans la région de Villefranche-sur-mer : biologie, écologie et variations quantitatives des populations. Thèse doctorale. Université Pierre et Marie Curie, 235 p.

PRELIMINARY RESULTS OF THE GROWTH RATES OF DEEP "CORALLIGENE" ALGAL BANKS IN THE BAY OF MARSEILLES (RIOU ISLAND) AND IN CORSICA (SCANDOLA RESERVE), WITH THE RADIOCARBON DATING METHOD

Stéphane SARTORETTO

Laboratoire de Biologie Marine et d'Ecologie de Benthos, Faculté des Sciences de Luminy, Marseille, France

Since the end of the nineteenth century (MARION, 1883), coralligenous formations in the Mediterranean have been the subject of an important series of biological and geological descriptions, especially along the French and Italian coasts (PÉRES and PICARD, 1952; LABOREL, 1961; LAUBIER, 1966; SARÀ, 1969; FROGET, 1974; HONG, 1980). Despite the importance of their distribution in the Mediterranean sea (LABOREL, 1987), the study of growth and erosion rates of these bioconstructions has never been initiated. Our work was carried out in the Bay of Marseilles (Grand Congloue-Riou Island) and in the Reserve of Scandola (Corsica). These sites present structures which are notable for their size and their beauty. We have tried to date the beginning of their development and to determine their mean growth rate. The southern point of Grand Congloue Island shows concretions between the depths of 35 m and 68 m. Coralline Algae predominating as primary frame builder, construct horizontal banks 1 m high at a depth of - 40 and - 60 m, and rims (1 to 2,50 m long) in coves of cliffs between - 45 and - 58 m. The site of "les Orgues" (Scandola) presents coralligenous rims and lips between - 40 and - 60 m. Although they are not as large as Marseilles' structures, in some places they are 2 m long.

In these stations, we have removed segments of sections terminal parts of 5 algal lips (30 to 40 cm long from apex) with hammer and burin by scuba diving : 3 in Grand Congloue and 2 in the Reserve of Scandola. These blocks have been measured and longitudinally cut with a circular saw. We have extracted 2 or 3 samples per bloc at different distances from apex. The algal framework has been cleared from recently formed calcareous (Serpulid worms, Bryozoans, etc.). Samples weighing about 40 grams cooked for 12 hours in an oven at 300°C for destruction of organic matter, attacked by orthophosphoric acid and dated by the method of liquid scintillation on benzene (EVIN, 1992) in the Laboratory of Geochronology of Quaternaries (L.G.Q. Luminy, Marseilles). We have calculated the net accretion rate in coralligenous rims between two consecutive dated samples.

Datings showed in table 1 have not been corrected, because in the Mediterranean sea there are no references in literature allowing the correction of the errors due to contamination by the large-scale testing of thermonuclear weapons and by the apparent age of the surface of water (BARD, 1988). Nevertheless, our results show that deep "coralligene" algal banks in the Bay of Marseilles and in Corsica are old (dated between 3830 and 7140 years B.P in our study.). Net accretion rates are low (< 1 mm.year^{-1}) and are comparable to those of infralittoral bioconstructions of *Mesophyllum lichenoides* (SARTORETTO, 1994). However, as for the Rhodolithes studied by LITTLER *et al.* (1991), they decrease in time. In the Bay of Marseilles and in Corsica, banks have stopped growing and have recently started their development again. Thus, the taking zone of the sample S2B (table. 1) is separated, by a thick layer of iron oxide, from a 15 mm thick layer of current Coralline algae (Sample : L.G.Q. 987) located in the upper side of the apex of the algal lip.

As we have dated the terminal part of massive rims, our results lead to suppose that theses bioconstructions must have developed on the littoral coasts during the Holocene transgression, which confirms the hypothesis of LAUBIER (1966) about "coralligene" algal banks of Banyuls (France). These first results also confirm the stop of the growth observed by LABOREL (1961) in the Bay of Marseilles. Despite the absence of references concerning the bioerosion rates, it allows to suppose that this stop took places over a long time in which eroding agents have left bare the old parts of structures on which recently new thalli of Coralline algae settled. Considering our data as new and preliminary, complementary measures are essential along the Mediterranean coast. Therefore the using of under-water drilling techniques in scuba diving will be necessary in great depth.

Station	Depth	Sample	H : Samp/apex (mm)	Age (years B.P.)	Growth rate (mm.y^{-1})
Riou	55 m	L.G.Q. 964 R1B	350	6840 ± 160	0,78
	55 m	L.G.Q. 963 R1A	195	6640 ± 150	
Riou	55 m	L.G.Q. 963 R1A	195	6640 ± 150	0,34
Riou	55 m	L.G.Q. 965 R1C	60	6240 ± 140	
Riou	55 m	L.G.Q. 990 R2A	300	6480 ± 150	0,65
Riou	55 m	L.G.Q. 1088 R2B	150	6250 ± 160	
Riou	55 m	L.G.Q. 989 R3A	300	7140 ± 190	0,26
Riou	55 m	L.G.Q. 1040 R55A	100	6360 ± 220	
Riou	40 m	L.G.Q. 1047 R40A	700	3830 ± 180	0,18
Scandola	50 m	L.G.Q. 992 S2A	620	6260 ± 180	0,63
Scandola	50 m	L.G.Q. 986 S2C	400	5910 ± 150	
Scandola	50 m	L.G.Q. 986 S2C	400	5910 ± 150	0,16
Scandola	50 m	L.G.Q. 1045 S2B	210	4740 ± 190	

Ages and growth rates of "coralligene" algal banks in Riou Island and in the Reserve of Scandola. H : , distance between the sample and the apex, for a same algal lip.

REFERENCES

BARD E., 1988. Correction of accelerator mass spectrometry ^{14}C ages measured in planktonic foraminifera : paleoceanographic implications. *Paleoceanography*, 3 (6) : 635-645.

EVIN J., 1992. Les datations par le radiocarbone en géologie et en archéologie. Fiabilité de la méthode selon l'origine et l'état des matériaux. *Docum. Lab. Géol. Lyon*, 122 : 87-92.

FROGET C., 1974. Essai sur la géologie du précontinent de la Provence occidentale. Thèse Doc. Etat, Univ. Aix-Marseille II : 1-225.

HONG J.S., 1980. Etude faunistique d'un fond de concrétionnement de type coralligène soumis à un gradient de pollution en Méditerranée nord-occidentale (golfe de Fos). Thèse Doc. Etat, Aix-Marseille II.

LABOREL J., 1961. Le concrétionnement algal "coralligène" et son importance géomorphologique en Méditerranée. *Rec. Trav. Stat. Mar. End. 23* (67). LABOREL J., 1987. Marine biogenic constructions in the Mediterranean. A review. *Sci. rep. Port-Cros natl. Park*, 13 : 97-126.

LAUBIER L., 1966. Monographie biocenotique : le coralligène des Albères. *Annls. Inst. Oceanogr.*, Paris, 43 (2) : 137-316.

LITTLER, M.M., Littler, D.S., Hanisak, M.D, 1991. Deep-water rhodolith distribution, productivity, and growth history at sites of formation and subsequent degradation. *J. Exp. Mar. Biol. Ecol.* 150 : 163-182.

MARION 1883. Esquisse d'une topographie zoologique du golfe de Marseille. *Ann. Mus. Hist. Nat. Marseille*, 1 (1) : 1-160.

PÉRÈS, J.M., PICARD J., 1952. Notes sur les fonds coralligènes de la région de Marseille. *Arch. Zool. exp. gén.*, 88 (1) : 24-38.

SARÀ M., 1969. Research on coralligenous formations : problems and perspectives. *Publi. Staz. Zool. Napoli*, 37 : 124-134.

SARTORETTO, S. 1994. Structure et dynamique d'un nouveau type de bioconstruction à *Mesophyllum lichenoides* (Ellis) Lemoine (Corallinales, Rhodophyta). *Comp. Rend. Acad. Scien.* 317 : 156-160.

B

B

CROISSANCE LINÉAIRE RELATIVE D'*ARBACIA LIXULA* (LINNAEUS) DANS LE GOLFE DE TUNIS

Fériel SELLEM

Laboratoire Fredj Kartas de biologie et d'écologie littorales,
Faculté des Sciences de Tunis 1060, Tunisie

Arbacia lixula (Linnaeus) figure parmi les espèces d'oursins les plus communes de la Méditerranée. Dans ce secteur, les études réalisées sur les aspects de sa morphométrie sont rares (REGIS, 1978 et BALLESTEROS, 1981). En Tunisie, les données biométriques concernant *Arbacia lixula* sont inexistantes. Afin de combler partiellement cette lacune, nous rapportons dans cette note les principales données biométriques concernant les caractères morphologiques. Nous avons effectué des prélèvements mensuels *d'Arbacia lixula* dans la région de Port Prince (secteur Sud-Est du golfe de Tunis) caractérisée par un substrat dur recouvert d'algues encroûtantes. Cet oursin se trouve sur les rochers littoraux entre 0,5 et 3 m où il adopte une position de résistance à l'arrachement. Il vit le plus souvent associé avec des petits regroupements de 3 à 4 individus de *Paracentrotus lividus*. *Arbacia lixula* est peu abondant, il représente 8,9 % des oursins échantillonnés.

Durant la période d'octobre 1988 à septembre 1989, nos observations ont porté sur 101 individus dont les valeurs extrêmes du diamètre du test varient de 27 à 62 mm et les poids extrêmes sont compris entre 11et 78 g. A l'aide d'un pied à coulisse gradué au 1/10 de mm nous avons mesuré 5 caractères linéaires qui sont : le diamètre du test D, la hauteur du test H, le diamètre de l'ouverture péristoméale Opst, le diamètre de l'ouverture périproctale Opct et la hauteur de la lanterne d'Aristote Hl. La méthode statistique utilisée consiste à calculer les équations de régression décrivant les relations existant entre le diamètre du test D pris comme longueur de référence et les autres paramètres linéaires. Nous avons également calculé les indices morphométriques correspondant aux rapports en pourcentage des différentes variables sur le diamètre du test D. Ces indices ont été calculés individuellement, puis groupés par classe de taille de 5 mm. Les équations établies par la méthode des moindres rectangles (AMR), données dans le tableau 1 décrivent une croissance relative différente suivant les caractères considérés. Ces équations ont été comparés aux résultats fournis par REGIS (1978), d'après des observations d'individus récoltés dans le golfe de Marseille.

Tableau 1 : Equations liant le diamètre du test D aux autres paramètres linéaires.

	Golfe de Tunis (présent travail)	Golfe de Marseille (REGIS,1978)
Hauteur du test	H = 0,264D1,116	H = 0,478D1,002
D. de l'ouverture péristoméale	Opst = 0,686D0,893	Opst = 0,736D0,919
D. de l'ouverture périproctale	Opct = 0,072D1,053	Opct = 0,171D0,851
H. de la lanterne	Hl = 0,403D0,983	Hl = 0,409D1,001

La croissance de la hauteur du test est majorante. Pour un intervalle de taille compris entre 27 et 62 mm, l'indice moyen H/D varie de 0,456 à 0,523. La représentation graphique des indices moyens en fonction de la taille confirme cette croissance majorante (Fig. 1).

Le diamètre de l'ouverture péristoméale présente une allométrie minorante. Pour le même intervalle de taille, les indices extrêmes varient entre 0,483 et 0,442. L'évolution de la représentation graphique des indices moyens Opst/D est progressive et confirme la relation d'allométrie minorante (Fig. 2).

La croissance de la hauteur de la lanterne est minorante. Pour des tailles extrÍmes (27 et 62 mm) les indices moyens calculés sont respectivement de 0,380 et de 0,375. La représentation graphique des indices Hl/D en fonction de la taille illustre encore ce faible rythme de croissance (Fig. 3).

Le diamètre de l'ouverture périproctale croit isométriquement par rapport au diamètre. Pour un diamètre de 27 mm, l'indice moyen est de 0,086 alors que pour un diamètre de 62 mm, l'indice est de 0,090. La représentation graphique des indices Opct/D en fonction de la taille est irrégulière et présente de nombreuses fluctuations (Fig. 4).

Mis en parallèle avec les résultats de REGIS (1978), tous les paramètres considérés présentent une croissance différente à l'exception de l'ouverture péristoméale. En effet :

- la croissance de la hauteur du test est majorante dans le golfe de Tunis et isométrique dans le golfe de Marseille.
- l'accroissement du diamètre de l'ouverture périproctale est isométrique dans la région de Tunis et minorant dans la région marseillaise.
- la croissance de la hauteur de la lanterne est minorante dans la golfe de Tunis et isométrique à Marseille.

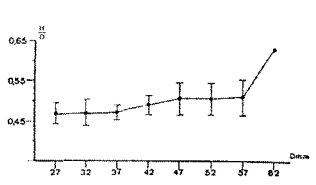


Fig .1:Variation de l'indice moyen (H/D)en fonction du diamètre (D).

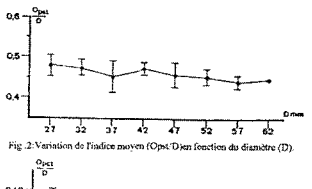
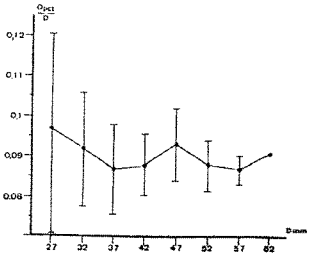


Fig .2:Variation de l'indice moyen (Opst/D)en fonction du diamètre (D).

Fig .3 Variation de l'indice moyen (Hl/D)en fonction du diamètre (D).



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

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

RÉFÉRENCES

BALLESTEROS E., 1981. Some biometric data from *Paracentrotus lividus* (Lmk.), *Arbacia lixula* (L.) and *Sphaerechinus granularis* (Lmk.) (Echinodermata Echinoidea). *Oecologia aquatica*, 5 : 227 - 231.

REGIS M. B., 1978. Croissance de deux échinoides du golfe de Marseille ((*Paracentrotus lividus* Lmk) et *Arbacia lixula* (L)). Aspects écologiques de la microstructure du squelette et de l'évolution des indices physiologiques. Thèse Doct. Etat.Fac. Sci. Tech. St. Jérôme, Fr., 221 pp.

DONNÉES SUR L'INDICE GONADIQUE ET L'INDICE DE RÉPLÉTION D'*ARBACIA LIXULA* (LINNAEUS) DANS LE GOLFE DE TUNIS

Fériel SELLEM

Laboratoire Fredj Kartas de biologie et d'écologie littorales,
Faculté des Sciences de Tunis, 1060, Tunisie

Pour apprécier l'intensité de l'alimentation et les modalités de la reproduction d'*Arbacia lixula* dans le golfe de Tunis, nous avons étudié les variations temporelles de l'indice de réplétion IR et celles de l'indice gonadique IG. Le premier est défini comme le rapport de la masse du tube digestif sec sur le diamètre du test au cube, le deuxième indice est égal au rapport de la masse de la gonade sèche sur le diamètre du test au cube. L'interférence de ces deux phénomènes permet de délimiter la période de ponte, l'époque de mâturation et les rythmes d'alimentation.

D'octobre 1988 à septembre 1989, nous avons effectué mensuellement des échantillonnages de l'oursin *Arbacia lixula* dans la région de Port Prince (secteur Sud-Est du golfe de Tunis). 101 individus (56 mâes et 45 femelles) ont été récoltés manuellement par plongée autonome à des profondeurs ne dépassant pas les 3 mètres. Le diamètre du test a été mesuré sans les piquants au 1/10 de mm à l'aide d'un pied à coulisse. Les gonades et les contenus digestifs ont été pesés après un séjour de 24 heures dans une étuve à 90°C.

Les résultats des variations mensuelles de l'indice gonadique et de l'indice de réplétion sont illustrés par la figure ci-dessous :

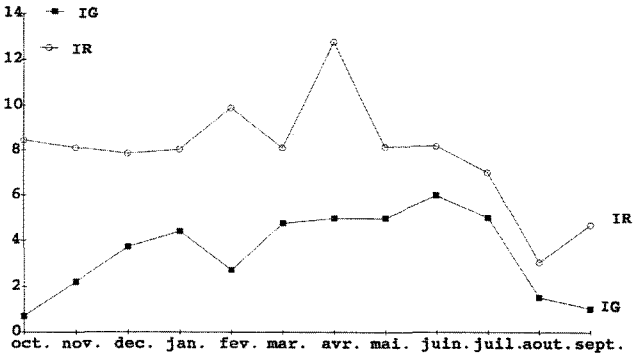


Figure 1 : Variations mensuelles des indices IG et IR chez *Arbacia lixula* dans le golfe de Tunis.

L'évolution annuelle de l'indice gonadique est assez régulière. L'amplitude de variation est de 5,3 ; elle est comprise entre un minimum de 0,7 en octobre et un maximum de 6 en juin. De mars à mai, l'indice gonadique se stabilise autour d'une moyenne de l'ordre de 5. Un pic d'accroissement brusque de l'IG se produit en juin et correspond à l'époque de forte mâturation estivale des gonades. La chute brutale de cet indice en juillet et qui s'achève en octobre indique l'émission principale des produits sexuels. A partir de novembre, l'IG augmente mais accuse une légère baisse en février qui indique une seconde émission des produits sexuels. Il semblerait que dans le golfe de Tunis, les pontes d'*Arbacia lixula* s'effectuent en été et en début d'automne.

L'indice de réplétion IR présente également une évolution assez régulière. L'amplitude de variation est de 9,7 et varie entre un minimum de 3 enregistré en août et un maximum de 12,7 en avril. On note une période de fort accroissement de cet indice d'août à avril et une diminution d'avril à août. Ces observations mettent donc en évidence une phase d'activité trophique intense au printemps et une autre plus réduite qui s'étend de la fin de l'été à l'hiver.

Dans le golfe de Tunis, l'évolution simultanée des deux indices montre que l'IG présente un décalage de un mois par rapport à l'IR. La période de grande activité gonadique est suivie d'une période de ralentissement de l'alimentation.

Dans le golfe de Marseille, REGIS (1978) constate que l'évolution annuelle de l'indice gonadique et de l'indice de réplétion est simultanée. A partir du mois d'avril, les deux indices présentent un accroissement rapide suivi d'un pic aigu au mois de mai et un minimun très marqué au mois de juin.

La confrontation de tous ces résultats montre que chez *Arbacia lixula* l'époque de mâturation des gonades ainsi que la période de ponte sont plus tardives dans le golfe de Tunis que dans le golfe de Marseille. Nous pouvons affirmer que les modalités de la reproduction et les rythmes de l'alimentation de cette espèce d'oursin ne sont pas semblables entre ces deux secteurs méditerranéens.

RÉFÉRENCES

REGIS M. B., 1978. Croissance de deux échinoides du golfe de Marseille (*Paracentrotus lividus* Lmk) et *Arbacia lixula* (L)). Aspects écologiques de la microstructure du squelette et de l'évolution des indices physiologiques. Thèse Doct. Etat Fac. Sci. Tech. St. Jérôme, Fr., 221 pp.

SUR LA DIVERSITÉ ACTUELLE DE LA MACROFAUNE BENTHIQUE DU LITTORAL ROUMAIN

Victoria TIGANUS et Camelia DUMITRACHE

Institut Roumain de Recherches Marines, Constantza, Roumanie

Pendant les 10 - 15 années dernières, les communautés benthiques du littoral roumain ont subi d'importantes modifications, l'une d'elle étant la réduction de la diversité (GOMOIU, 1985; TIGANUS, 1983). Nous allons présenter la diversité du macrozoobenthos du substrat sédimentaire, à la suite des recherches effectuées en 1993 sur un réseau de 28 stations, dont 18 dans une zone au nord de Constantza et 4 dans la zone de Mangalia (fig.1). Nous avons réalisé trois séries de prélèvements (mars, août, septembre) et nous avons identifié 40 espèces macrobenthiques, un nombre relativement faible comparé à celui de la période 1960-1965 (BACESCU *et al.*,1971). Le nombre d'espèces enregistrées par station a varié de 2 à 21, avec des différences importantes entre la zone nord et les zone sud (Constantza et Mangalia) (fig:1). Dans les 18 stations du nord, nous avons identifié 20 espèces (2 à 9 par station), dans les 6 stations de la zone Constantza, 36 espèces (8 à 20 par station) et dans les 4 stations de la zone Mangalia, 27 espèces (11 à 21 par station). On constate aussi des différences importantes dans la fréquence des espèces dans les échantillons :
- au nord, trois espèces seulement ont dépassé 50% (les polychètes *Neanthes succinea* Leuk., *Polydora limicola* Annenk. et le bivalve *Mya arenaria* L., toutes les trois étant des éléments opportunistes),
- dans la zone Constantza, 6 espèces ont dépassé la fréquence de 50% (les polychètes *N. succinea, P. limicola, Melinna palmata* Grube et les bivalves *Mya arenaria* L. et *Mytilus galloprovincialis* Lam.),
- dans la zone Mangalia, 13 espèces dépassaient la fréquence de 50%, les plus importantes étant les polychètes *Phyllodoce maculata* (L), *N. succinea, Nephthys hombergi*, le bivalve *M. galloprovincialis*, le tanaidacé *Apseudopsis ostrumovi* Bac. et Car., les amphipodes *Ampelisca diadema* Costa et *Phtisica marina* Slabb., etc..

La composition spécifique du macrozoobenthos par groupes systématiques se caractérise, au nord, par la dominance des espèces de polychètes (45% du nombre total d'espèces) et par une présence plus faible des mollusques (20%), crustacés (20%) et d'autres groupes (15%). Au Sud (Constantza et Mangalia), le taux des crustacés (30%) et des autres groupes (20-22%) augmente. L'indice de diversité (H) (Shannon-Wienner) a également des valeurs bien inférieures au Nord par rapport au Sud.

Station	1	2	3	4	5	6	7	8	9	10	11	12	13	14
H	0.56	2.1	1.88	0.64	2.15	0.83	1.74	0.60	1.58	1.37	1.45	0.60	1.98	0.00
Station	15	16	17	18	19	20	21	22	23	24	25	26	27	28
H	0.91	0.64	1.57	0.85	2.49	1.95	1.32	2.84	3.29	3.26	2.77	3.41	3.20	3.12

Au nord de Constantza, pour 8 stations H a été inférieur à 1; pour 7 stations, ses valeurs étaient de 2-3 (tab.1) (la moyenne de H pour les 18 stations est de 1.19). Dans la zone Constantza, H n'a jamais été au dessous de 1, dépassant la valeur 3 en trois stations (la moyenne de H est 3.12). Dans la zone Mangalia, dans 3 des 4 stations, H a dépassé 3; dans la quatrième, il est resté un peu inférieur à 3 (la moyenne de H est 3.12). La zone Nord est soumise à l'influence directe de l'apport fluvial danubien, mais la zone littorale est dépourvue d'habitations et d'industrie. En revanche, les zones sud sont plus éloignées de l'influence du Danube, mais le littoral est très urbanisé, industrialisé, avec un trafic naval et des ports importants.

Nos données prouvent que le zoobenthos a une structure plus dégradée dans la zone nord de Constantza : un appauvrissement spécifique général, un petit nombre d'espèces des crustacés et des groupes moins tolérants, valeur basse des indices de diversité et forte dominance des espèces opportunistes. Cette situation reflète l'influence négative de premier ordre de l'apport fluvial des dernières années sur les écosystèmes marins du littoral roumain. Cette influence se manifeste d'abord par un haut degré d'eutrophisation et, par la suite, la zone Nord est affectée par les plus amples et les plus fréquentes floraisons, avec de graves conséquences sur les populations benthiques.

REFERENCES

BACESCU M., MULLER G.I., GOMOIU M.T.,1971. Cercetari de ecologie bentala in Marea Neagra. Ecologie marina. Ed. Academiei R.S.R., 4, 357 pp.

GOMOIU M.T. 1985. Exposé de synthèse : Sur l'état du benthos du plateau continental roumain. *Rapp. Comm. int. Mer Médit.*, 29, 5 : 199-204

TIGANUS V.,1983. Modifications dans la structure de la biocénose des sables à *Corbula mediterranea* (Costa) du littoral roumain. *Rapp. Comm. int. Mer Médit.*, 28 :3 : 205-206.

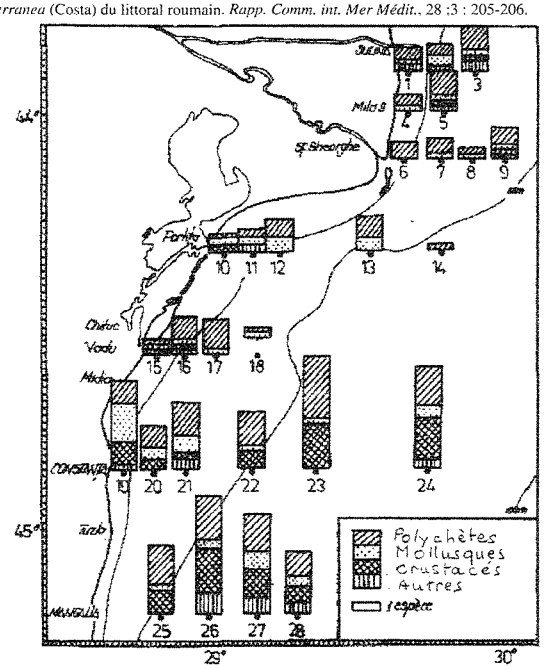


Fig. 1. Nombre d'espèces et structure qualitative par groupes du macrozoobenthos

SEXUALITÉ DE *PINCTADA RADIATA* (LEACH, 1814) DANS LES ÎLES KERKENNAH (TUNISIE)

Sabiha TLIG- ZOUARI

Laboratoire Fredj Kartas de Biologie et d'Ecologie Littorales,
Faculté des Sciences de Tunis, Campus Universitaire, 1060 Tunis, Tunisie

Le bivalve *Pinctada radiata* a une répartition géographique circonscrite aux tropiques. A l'origine indo-pacifique, il semble avoir assez récemment colonisé la Méditerranée. Les populations méditerranéennes de *Pinctada radiata* n'ayant fait l'objet d'aucune étude biologique, ce travail fournit les premières données sur leur sexualité. Les Pintadines étudiées proviennent d'échantillons récoltés autour des îles Kerkennah entre 1 et 3 m de profondeur au cours de l'année 1986-1987 à raison d'une fois par trimestre. 202 individus ont été rangés par classe de taille de 5 mm (hauteur de la coquille). La reconnaissnce des sexes est basée sur des critères macroscopiques et des observations histologiques.

L'identification du sexe a été réalisé sur les 202 individus de taille comprise entre 5 et 72 mm. Les observations montrent un nombre de 112 femelles, 80 mâles et 10 juvéniles dont le sexe n'est déterminable ni macroscopiquement ni microscopiquement. Avec 58,33%, la dominance des femelles est significative (X^2 = 5,33) pour 41,66% de mâles (Tab. 1). La hauteur des coquilles des individus mâles est comprise entre 17 et 67 mm (Fig. 1) avec une moyenne de 40,3 mm. Celle des femelles est hautement significative comme le prouve le test t = 9,73. La diminution des proportions des mâles en fonction de la taille est progressive et régulière. Il est possible de distinguer deux tranches de taille de six classes chacune :
- Pour la première entre 17 à 42 mm, nous dénombrons 51 mâles et 16 femelles. L'écart est hautement significatif (X^2 = 18,28) et met en évidence une nette dominance des mâles.
- La deuxième tranche concerne les plus gros individus et renferme 28 mâles (22,5%) et 96 femelles (77,5 %). La dominance des femelles est très significative comme le prouve X^2 = 37,29.

En conclusion, la différence entre les moyennes de taille des mâles et des femelles est hautement significative pour les classes 17 à 42 et 47 à 72. Les individus sont d'abord exclusivement mâles de la classe 17 à la classe 27. Les premières femelles apparaissent à la classe 32 mm. A partir de la classe 47, la phase femelle domine avec plus de 60% de l'effectif. Ces résultats confirment ceux de TRANTER (1958 b et c) qui avait remarqué que la majorité des individus jeunes sont des mâles et des gros individus sont des femelles et plaident en faveur d'un hermaphrodisme protandre. L'inversion sexuelle se ferait de la taille 32 à 57 mm, à partir de l'âge de un an environ pour les individus les plus précoces, alors qu'à un âge approximatif de trois ans, les individus deviennent pratiquement tous femelles. En d'autres termes, l'inversion sexuelle de la plus grande partie de la population se ferait entre 1 et 3 ans.

Classes de taille (mm)	Mâles N	Mâles %	Femelles N	Femelles %	X_2
17	1	100,00	0		1,00
22	10	100,00	0		10,00
27	7	100,00	0		7,00
32	8	80,00	2	20,00	3,60
37	14	70,00	6	30,00	3,20
42	12	60,00	8	40,00	0,80
47	8	33,10	13	61,90	1,19
52	6	28,57	15	71,43	3,86
57	8	28,57	20	71,43	5,14
62	5	16,13	26	83,87	14,23
67	1	5,56	17	94,44	14,22
72	0	0,00	5	100,00	5,00
TOTAL	80	41,67	112	58,33	5,33

Table 1 : variation des proportions numériques des sexes de *P. radiata* en fonotion de la taille (hauteur de la coquille).

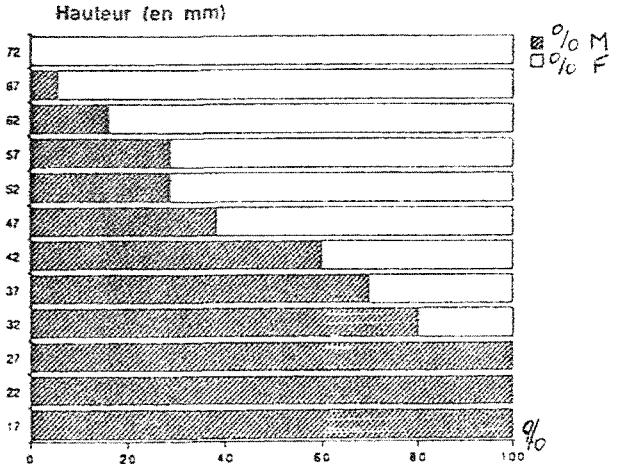


Figure 1 : variation de la fréquence en % des mâles (M) et des femelles (F) en fonction de la hauteur de la coquille.

RÉFÉRENCES

TRANTER, D. J., 1958 b. II. *Pinctada albina* (Lmk) : Gametogenesis. *Australian J. Mar. Fresh. Res.*, 9 : 144-158.

TRANTER, D. J., 1958 c. III. *Pinctada albina* (Lmk) : Breeding season and sexuality. *Australian J. Mar. Fresh. Res.*, 9 : 191-216.

B

B

LES HYDROIDES DE LA MER DE MARMARA

Ismail ÜNSAL

Faculté des Sciences, Départment de Biologie, Sec. Hydrobiologie,
Université d'Istanbul, Turquie

Cette recherche a été faite dans le but de découvrir les différentes espèces d'Hydroides de la mer de Marmara. Jusqu'à nos jours, aucune recherche sérieuse n'avait été effectuée dans ce domaine dans les eaux territoriales turques de la Méditerranée orientale, la mer Egée et la mer Noire. Ce n'est que dans une seule région de la mer de Marmara que certaines études avaient été réalisées : aux alentours du Bosphore et des îles de Princes (DEMIR, 1952). Le sujet a été traité lors d'une étude générale faunistique et 23 espèces ont été déterminées. Certes, ce chiffre ne correspondait pas au nombre d'espèces vivant dans la mer de Marmara. Pour ce qui est de la Méditerranée, plusieurs auteurs ont approximativement fixé une centaine d'espèces; NAUMOV (1960) et MANEA (1968) ont déterminé 18 espèces dans la mer Noire. La mer de Marmara se situant dans une région qui forme un passage entre la Méditerranée et la mer Noire, il était important de faire des recherches en vue de définir les différentes espèces pouvant s'y abriter.

Les échantillons de cette recherche ont été obtenus dans les matériels benthiques de profondeur (allant jusqu'à 200 m) et récoltés à l'aide d'engins comme le trawl, le beam-trawl, la drague, etc. Au cours des deux dernières années, des excursions régulières se sont poursuivies tous les mois dans le but de récolter les colonies avec des individus reproducteurs. Le matériel benthique de la mer de Marmara a été ainsi récolté dans plus de 250 stations.

Pour déterminer les espèces, nous nous sommes référés aux auteurs suivants : CORNELIUS, 1975, 1979, 1982; CORNELIUS & GARFATH, 1980; DEMIR, 1952; GILI *et al.*, 1989; HINCKS, 1868; MANEA, 1968; MORRI & BOERO, 1986; NAUMOV, 1960; RAMIL *et al.*, 1992; SVOBODA & CORNELIUS, 1991; VERVOORT, 1972.

A la suite de cette recherche, nous avons fixé l'existence de 38 espèces vivant dans la mer de Marmara. Dix-huit d'entre elles ont été récemment découvertes aussi bien dans la faune de Marmara que dans celle de la Turquie. Ces espèces sont : *Bougainvillia ramosa* (Van Beneden, 1844), *Dicoryne conferta* (Alder, 1856), *Hydractinia echinata* (Fleming, 1828), *Eudendrium ramosum* (Linnaeus, 1758), *Stegopoma fastigiatum* (Alder, 1860), *Halecium halecinum* (Linnaeus, 1758), *Halecium beanii* (Johnston, 1838), *Filellum serratum* (Clarke, 1879), *Filellum serpens* (Hassal, 1848), *Lafoea gracillima* (Alder, 1856), *Acryptolaria conferta conferta* (Allman,1877), *Orthopyxis caliculata* (Hincks, 1863), *Obelia flabellata* (Hincks, 1863), *Laomedea exigua* (Sars, 1857), *Plumularia syriaca* (Billard, 1930), *Nemertesia antennina* (Linnaeus, 1758), *Nemertesia ramosa* (Lamouroux, 1816), *Thecocarpus myriophyllum* (Linnaeus, 1758).

D'autre part, nous avons trouvé les 20 autres espèces dans des zones qui n'avaient pas été prospectées auparavant, ce sont : *Syncoryne sarsii* (Loven, 1835), *Syncoryne eximia* (Allman, 1864), *Tubularia larynx* (Linnaeus, 1758), *Podocoryne carnea* (Sars,1846), *Perigonimus repens* (Wright, 1857), *Atractylis arenosa* (Alder, 1857), *Eudendrium capillare* (Alder, 1856), *Eudendrium rameum* (Pallas, 1766), *Sertularella polyzonias* (Linnaeus, 1758), *Lafoea dumosa* (Fleming ,1820), Clytia hemsiphaerica (Linnaeus, 1767), Obelia bidentata (Clarke, 1875), *Obelia gelatinosa* (Pallas, 1766), *Obelia dichotoma* (Linnaeus, 1758), *Gonothyraea gracilis* (Sars, 1857), *Gonothyraea loveni* (Allman, 1859), *Laomedea angulata* (Hincks, 1861), *Laomedea flexuosa* (Alder, 1857), *Plumularia halecioides* (Alder, 1859), *Aglaophenia pluma* (Linnaeus, 1758).

Fig. 1: La mer de Marmara

REFERENCES

CORNELIUS, P.F.S.,1975. The hydroid species of *Obelia* (Coelenterata, Hydrozoa: Campanulariidae), with notes on the medusa stage. *Bull. Br. Mus.* (Nat.Hist.), Zool., 28 (6) : 249-293

CORNELIUS, P.F.S.,1979. A revision of the species of *Sertulariidae* (Coelenterata: Hydroida) recorded from Britain and nearby seas. *Bull. Br. Mus.* (Nat.Hist.) Zool., 34 (6) : 243-321.

CORNELIUS, P.F.S. and GARFATH,J.B., 1980. The coelenterate taxa of Joshua Alder. *Bull. Br. Mus.* (Nat.Hist.) Zool., 39 (5 : 273-291

CORNELIUS, P.F.S., 1982. Hydroids and medusae of the family Campanulariidae recorded from the eastern North Atlantic, with a world synopsis of genera. *Bull. Br. Mus. Nat. Hist.* (zool.), 42 (2) : 37-148

DEMIR, M., 1952. Bogaz ve adalar sahillerinin omurgasîz dip hayvanlarî. I.Ü. Fen. Fak. Hidrobioloji Ara,. *Enst. Yayîn.* 3 : 32-72

GILI, J.M., VERVOORT, W. and PAGES,F., 1989. Hydroids from the West African coast : Guinea Bissau, Namibia and South Africa. *Scient. Mar.*, 53 (1) : 67-112

HINCKS, T., 1868. A history of the British hydroid zoophytes. London.1:1-338, 2 : 1-67 Pls.

MANEA, V., 1968. Contributions à l'étude des hydraires de la mer Noire. *Trav. Mus. Hist. Gr. Antipa.*, 8 : 279-284.

MORRI, C. and BOERO, F., 1986. Catalog of main marine fouling organisims. Hydroids. Odema. Vol.7, 91 p.

NAUMOV, D.V.,1960. Hydroids and hydromedusae of the USSR. Acad. Sc. U.R.S.S., n°70 : 1-571 (in Russian). Israel program for scientific translations.1969 : 1-660 p.

RAMIL, F., PARAPAR, J. and Vervoort, W.,1992. The genus Sertularella Gray, 1848 (Cnidaria: Hydroida) along the coasts of Galicia (Spain). *Zool. Verh. Leiden.* 66 : 16-40 :493-524.

SVOBODA, A., 1979. Beitrag zur ökologie, biometrie und systematik der Mediterranen Aglaophenia Arten (Hydroidea). *Zool. Verh. Leiden.*167 : 1-114, pls 1-9.

SVOBODA, A. and CORNELIUS, P.F.S., 1991. The European and Mediterranean species of Aglaophenia (Cnidaria: Hydrozoa). *Zool. Verh. Leiden.* 274 : 1-72, Figs.1-25.

VERVOORT W., 1972. Hydroids from the Theta, Vema and Yelcho cruises of the Lamont-Doherty geological observatory. *Zool. Verh. Leiden.*120 : 1-247, Figs.1-83.

BRYOZOAN AND FORAMINIFERAN FAUNAS OF THE QUATERNARY SEDIMENTS FROM IZMIT BAY

Ismail ÜNSAL[1], Antonietta ROSSO[2], Engin MERIC[3], Oktay CETIN[4]

[1] Istambul Universitesi, Fen Fak., Biyoloji Bölümü, Vezneciler, Istambul, Turkey
[2] Istituto Policattedra di Oceanologia e Paleoecologia, Corso Italia, 55, Catania, Italy
[3]Istambul Universitesi, Muhendislik Fak.,Jeoloji Mühendisligi Bölümü, Istambul, Turkey
[4] O.D.T.U., Fen-Edebiyat Fak., Fizik Bölümü, 06531 Ankara, Turkey

Quaternary faunas of the Sea of Marmara zone are still poorly known. This paper deals with bryozoans and forams from the Quaternary sediments of Izmit bay, a narrow embayment located along the eastern coast of the Sea of Marmara. The bay is elongated in a E-W direction in correspondence to the Pontide central uplift zone (SAKAMURA, 1971 fide PIRAZZOLI *et al.*, 1991) following the regional main geodynamic context. Recent sediments of Izmit Bay consist of muds, silts, sands, sandy and muddy clays and gravels which alternate with each other, sometimes within the thickness of a few metres, recording a strong variability of sedimentation trough time. Layers of gravels at depth are especially useful as guides in constructing the stratigraphy. Studied samples come from nine different drill-sites on a proposed bridge-crossing the bay. From the South to the North, these are KS-2, S-5, S-3, S-8, S-7, S-2, S-4, S-1 and S-6. Only the southermost drill-site (KS-2) is located on land while the other eight are situated in the bay. Seven of these drills end at about 80 metres in the Quaternary sediments, while only the two northernmost ones (S-1 and S-6) reach the overlying substratum (locally represented by Triassic rocks) at 50 and 26.50 m, respectively. Bryozoans are completely absent from SK-2 and S-4 cores and usually lacking or poorly represented in the basal parts of other cores. Moreover, they are present in sediments exclusively made up by gravels or to some extent containing gravels. Finally, bryozoan associations are typically oligo-to-monospecific comprising at most four species in a single sample. In most cases, only one taxon, sometimes with a single specimen, is found. On the whole, nine species, belonging to nine genera, have been found : *Crisia eburnea* (L.), *Caberea boryi* (Aud.), *Cellaria salicornioides* Lamoroux, *Scrupocellaria scruposa* (L.), *Escharoides mamillata* (Wood), *Schizomavella* sp., *Hippaliosina depressa* (Busk), *Cryptosula pallasiana* (Moll) and *Celleporina lucida* (Hincks). All live in the Recent Mediterranean Sea, except *Schizoporella* sp.. No species typical of the Black Sea has been found. From the analysis of the bryozan faunas, it has been possible to distinguish three different groups of cores :
1) S-2, S-3 and S-5 cores, characterized by the exclusive presence of *C. pallasiana*, an euryhaline species of the second degree (WINSTON, 1977), sometimes associated with *Schizomavella* sp.;
2) S-1 and S- 6 cores, showing a basal part somewhat similar to the previous group, while the top evolves to more rich and diversified communities comprising both euryhaline species of the first degree (WINSTON, 1977), such as *S. scruposa* and *C. eburnea* together with the normal marine species *C.boryi* and *E. mamillata*.
3) S-7 and S-8 cores, where only typical marine species, such as *C. boryi, C. salicornioides, H. depressa* and *C. lucida*, were discovered.

Foraminiferan faunas have been studied for the southernmost cores (S-5 and S-3). They are exclusively made up by benthic species and planctonic forms are lacking. Along S-5 core, between 8.00 and 22.70 m the following species have been determined : *Spiroloculina depressa* d'Orb., *Siphonaperta aspera* (d'Orb.), S. dilatata (le Calvez J. & Y.), *Massilina secans* (d'Orb.), *Quinqueloculina cf. bidentata* d'Orb., *Q. laevigata* d'Orb., *Q. seminula* (L.), *Milionella subrotunda* (Montagu), *Triloculina marioni* Schlumberger, *T. tricarinata* d'Orb., *Neoconorbina orbicularis* (Terquem), *Rosalina bradyi* Cushman, *Lobatula lobatula* (Walker-Jacob), *Cibicides floridanus* (Cushman), *Asterigerinata mamilla* (Williamson), *Ammonia compacta* (Hofker), *A. parasovica* Stshedrina-Mayer, *A. parkinsoniana* (d'Orb.), *Porosononion* sp., *Elphidium advenum* (Cushman), *E. complanatum* (d'Orb.), *E. crispum* (L.), *E. macellum* (Fichtel-Moll), *E. ponticum* Dolgopolskaya-Pauli. Along S-3 core, between 44.00 and 80.20 m the following species have been identified: *Spiroplectinella sagittula* (d'Orb.), *Textularia sagittula* Defrance, *T. truncata* Höglund, *Spiroloculina excavata* d'Orb., *S. ornata* d'Orb., *Cycloforina colomi* (Le Calvez J. & Y.), *Quinqueloculina limbata* d'Orb., *Q. seminula* (L.), *Biloculinella depressa* (Wiesner), *Milionella labiosa* (d'Orb.), *M. subrotunda* (Montagu), *Pthycomiliola separans* (Brady), *Pyrgo elongata* (d'Orb.), *Triloculina marioni* Schlumberger, *Lenticulina gibba* (d'Orb.), *Lagena mollis* Cushman, L. cf. *vulgaris* Williamson, *Favulina hexagona* (Montagu), *Brizalina alata* (Seguenza), *B. spathulata* (Williamson), *Cassidulina carinata* Silvestri, *Rectuvigerina phlegri* le Calvez, *Bulimina aculeata* d'Orb., *B. elongata* d'Orb., *B. marginata* d'Orb., *Reussella spinulosa* (Reuss), *Fursenkoina complanata* Egger, *Valvulineria bradyana* (Fornasini), *Neoconorbina orbicularis* (Terquem), *Rosalina bradyi* Cushman, *Hyalinea baltica* (Schröter), *Lobatula lobatula* (Walker-Jacob), *Cibicides advenum* (d'Orb.), *C. floridanus* (Cushman), *Planorbulina mediterranensis* d'Orb., *Asterigerinata mamilla* (Williamson), *Biasterigerina planorbis* (d'Orb.), *Hynesina depressula* (Walker-Jacob), *Pullenia sp., Nonionella opima* Cushman, *N. turgida* (Williamson), *Gyroidina umbonata* (Silvestri), *Aubignyna perlucida* (Heron-Allen-Earlan), *Ammonia compacta* (Hofker), *A. parasovica* Stshedrina-Mayer, *A. parkinsoniana* (d'Orb.), *Elphidium advenum* (Cushman), *E. crispum* (L.) and *E. macellum* (Fichtel-Moll). These foraminiferan associations allow us to refer the Izmit Bay sediments to the Quaternary.

Moreover, the occurrence of the same sediments (in particular the gravel layers) and of bryozoan and foraminiferan communities, recording similar environmental conditions, at different depths along the drill series, indicate that tectonic movements have affected the region during the Quaternary. Molluscs dated by ESR methods, suggest for the studied cores ages of 500 + 200 years for the top part at 37.00 m and 817,000 + 105,000 years for the lower part at a depth of 55.00 m. Considering the ages and the geometric relationships of sediments along the studied cores, under the control of the tectonics, three different unconformity events, probably interpreted as transgressions, could be identified in the Izmit bay area : an Eopleistocene event (817,000 + 105,000 yrs) corresponding to the lowest layer of slightly gravelly mud; it is followed by Lower-middle Pleistocene unconformities (664,000 + 94,000 yrs and 186.000 yrs); above, the Upper Pleistocene-Holocene sediments show unconformities at 35,000 + 8,100 yrs and 500 + 200 yrs. Bryozoan and foraminiferan associations together, exlusively made up of marine-to-euryhaline species suggest that Izmit Bay was under the influence of Mediterranean water, at least three times during the Pleistocene-Holocene. In contrast, the absence of species exclusively limited to the Black Sea testifies that it was, very likely, not linked, at any time, with this sea, as were other localities in the N part of the Marmara Sea (UNSAL, 1993).

REFERENCES

PIRAZZOLI P.A., LABOREL J., SALIEGE J.F., EROL O., KAYAN I. & PERSON A., 1991. Holocene raised shorelines on the Hatay coasts (Turkey) : Palaeoecological and tectonic implications. *Marine Geology*, 96 : 295-311.

UNSAL I., 1993. Distribution et répartition des bryozoaires fossiles dans les sédiments du sud du Bosphore et de la Corne d'Or et leurs implications paléoécologiques. *Rapp. Comm. int. Mer Medit.*, 33 : 55.

WINSTON J.E. , 1977. Distribution and ecology of estuarine Ectoprocts : a critical review. *Chesapeake Science*, 18 (1) : 34-57.

CONSIDÉRATIONS SUR DEUX ANNÉES D'ÉTUDE DE LA REPRODUCTION ET DE LA BIOMÉTRIE CHEZ *PROTEOPECTEN GLABER* (L.) DU GOLFE DE TRIESTE

Giorgio VALLI

Dipartimento di Biologia dell'Università degli Studi di Trieste, Italia

Une étude approfondie de la littérature a permis de repérer environ 1500 travaux (de 1800 à 1993) sur la biologie de diverses espèces de bivalves appartenant à la Famille Pectinidae mais unr seule recherche, de SARACINO *et al.* (1982), sur la reproduction et la biométrie chez *Proteopecten glaber* de l'Adriatique méridionale. L'espèce est commune sur des substrats détritiques-sableux du Golfe de Trieste et possède une vaste zone de distribution méditerranéenne (jusqu'à la mer Noire) et atlantique. On a recueilli de juin 1989 à septembre 1991, tous les mois, cent exemplaires provenant de pêches faites dans le Golfe de Trieste. On a mesuré, avec un pied à coulisse, les principaux paramètres de la coquille de tous les animaux (longueur, hauteur, épaisseur) et puis le poids total, celui des parties molles et des valves vides. Les parties molles de 20 exemplaires, choisis au hasard (random numbers), ont été fixées au Bouin, coupées (6 µm) et colorées à l'hématoxyline-éosine. Les gonades ont été classées selon une échelle histologique de 6 stades (VALLI *et al.*, 1990, 1992) : Stade 0 (repos sexuel), Stade 1 (début de la gamétogénèse), Stade 2 (développement), Stade 3 (maturité), Stade 4 (émission), Stade 5 (fin du cycle). Ensuite, on a calculé l'indice gonadique selon SEED (1980) qui synthétise par une seule valeur par mois la condition des gonades (sa valeur est 0 lorsque tous les individus sont en repos sexuel et 3 s'ils sont tous mûrs). 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. *Proteopecten glaber* est un hermaphrodite contemporain avec deux régions bien distinguées de la gonade : la région proximale, supérieure, blanchâtre, est mâle; celle distale, rose-orange, est femelle. La gonade est mûre ou en émission, selon les années (1990 et 1991), d'avril à août et de mai à septembre : on remarque les valeurs les plus élevées de l'indice gonadique (de 2,6 à 2,9) en avril-août. Le repos sexuel comprend la période septembre-décembre/janvier; en effet la gamètogénèse recommence en décembre ou janvier et prévaut jusqu'à mars/avril. Le test de Spearman a permis de faire ressortir une corrélation élevée parmi les indices de conditions des deux années (rho=0,85 pour $p < 0.01$). Selon SARACINO *et al.* (1982) dans l'Adriatique méridionale, l'espèce se reproduit de juin à septembre; en automne elle est en repos sexuel, tandis que la gamètogénèse reprend au début de l'hiver. En conclusion la stratégie reproductive de *Proteopecten glaber* est la même que celle adoptée par d'autres espèces de bivalves de Golfe de Trieste : *Mytilus galloprovincialis, Chamelea gallina, Ensis minor, Acanthocardia aculeata, Laevicardium oblongum* (VALLI *et al.*, 1975, 1981, 1985, 1990, 1992). Cette stratégié est appelée par LUCAS *et al.* (1978) de type " r ", caractérisée par un grand effort reproductif qui est favorisé par des conditions généralement favorables de température, salinité, oxygène, nourriture du Golfe de Trieste (MILANI *et al.*, 1988). Le fait qu'une espèce suive une telle stratégie, peut être expliquée, selon VALLI *et al.* (1992), soit par une faible densité de population, qui rend difficile la rencontre des gamètes dans l'eau, et/ou par une mortalité élevée, surtout larvaire.

En ce qui concerne la biométrie, la longueur moyenne des tous les animaux, recueillis en 1990, est de 5.1 cm (avec un intervalle de 3.6 - 7.2 cm) et de 4.8 cm (avec un intervalle de 3,4 - 6,7 cm) en 1991. L'étude de ces deux moyennes, et surtout l'étude des moyennes des échantillons mensuels, fait ressortir des différences significatives (test de Scheffé) qui sont attribuables aux changements naturels de la composition de la population de *Proteopecten glaber*, d'une année à l'autre, plutôt qu'à l'effet de la pêche, assez limitée à ce sujet dans le Golfe de Trieste. De plus, les longueurs observées correspondent à des animaux adultes qui s'étaient déjà reproduits : cette situation est due au fait que les animaux provenaient de la pêche professionnelle; or elle emploie des engins qui ont une sélectivité propre et, par conséquent, ne pêchent pas les animaux les plus petits. L'examen des échantillons mensuels a permis d'observer que la distribution des autres variables était assez proche de la normalité, sauf pour les variables non linéaires. Ensuite, on a calculé (sur données transformées en log10) des régressions fonctionnelles (Modèle II) pour suivre les variations de la croissance. Ces régressions ne peuvent pas être reportées pour des raisons d'espace. Ici on se limitera à observer que, relativement aux intervalles de mesure effectuées, l'hypothèse de croissance isométrique ne peut pas être refusée pour la plupart des régressions (tant parmi variables de même type que de type différent), sauf pour la régression "épaisseur sur longueur" pour laquelle on peut accepter l'hypothèse de croissance allométrique.

Enfin, dans le but de compléter et surmonter certaines limitations de l'analyse de la régression et de l'analyse de la covariance, on a comparé 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 préférer 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 paramètriques (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). Ensuite, 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 isolés 3 indices: Poids sec*1000/(Longueur)^3, Poids sec sans cendres/(Longueur)^3 et Poids sec sans cendres*1000/(Longueur*hauteur*épaisseur) qui ont révélé les plus petites variabilités intérieures, les plus grandes sensibilités et les meilleures corrélations avec le cycle reproducteur. Le dernier de ces indices est à préférer, car il contient plus d'information. Les 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: le fait que l'étude a été conduite pendant environ deux ans donne à ces résultats plus de fiabilité.

REFERENCES

LUCAS A., CALVO J. et TRANCART M., 1978. *Haliotis*, 9(2): 107-116.

MILANI L., CABRINI M, FONDA-UMANI S. et HONSELL G., 1987/88. *Nova Thalassia*, 9: 97-145.

SEED R., 1980. *J. Conch.* 30: 239-245.

VALLI G., CERNECA F. e FERRANTELLI N., 1975. *Boll. Pesca, Piscic.*, 30(2) : 300-313.

VALLI G., ZECCHINI-PINESICH G., 1981/82. *Nova Thalassia*, 5: 57-73.

VALLI G., MANSOTTI L., CERESI R. e NODARI P., 1985. *Nova Thalassia*, 7 : 5-38.

VALLI G., CERINO A. e NODARI P., 1990. *Rapp. Comm.i nt. Mer Medit.*, 32, 1 : 30.

VALLI G., VERONICO E., 1992. *Rapp. Comm. int. Mer Medit.*, 33, 1 : 356.

NOTE ON THE DECAPODS DISTRIBUTIONAL AFFINITY IN THE ALBANIAN COAST

Andrian VASO

Faculty of Natural Sciences, University of Tirana, Albania

The present paper deals with the results of a long-term (1985-1993) faunistic study on decapod crustaceans. The investigation reveals new information about 90 species, 45 of which are new records, increasing the number of known decapod species in Albanian waters to 114, which comprise 55,61% of the Adriatic fauna. Two species, *Thoralus sollaudi* (Zariquiey Cenarro, 1935) and *Calcinus tubularis* (Linnaeus, 1767) are reported for the first time from the Adriatic Sea, (VASO & GJIKNURI, 1993; VASO, in press, a; VASO, in press, b). These data, compared with STEVCIC's (1990) list of Adriatic decapods, rise to 205 the number of decapod species known from the area, if we exclude 7 species of this list whose presence needs further confirmation. The study was performed at 22 quadrats along the continental platform of the Albanian coast. Samples were collected from the shore to 260 m depth. In general, trawling was employed for soft substrates. In shallow waters to 5 m depth, specimens were sampled by hand and by diving during expeditions carried out at 13 coastal stations.

Qualitative affinity of the different sampling quadrats was estimated by the coefficient of Chekanowski :

$$C = 2a / 2a + b + c$$

where : a, the number of common species between quadrats 1 & 2; b, the number of species of quadrat 1 that do not exist in quadrat 2; c, the number of species of quadrat 2 that do not exist in quadrat 1.

Bottom type and biocenosis, as well as the level of abiotic and biotic environmental conditions are basic factors affecting the distribution of decapods. All these factors caused decapod fauna to differ in composition between studied quadrats, which is expressed by the coefficient affinity.

The dendrogram (Fig. 1) brings into evidence a clear cut separation among the shallow sampling quadrats and the deep one. In the shallow group, biotic distinction is characterized by the presence of species with a limited vertical distribution in mediolitoral and infralitoral, as well as by the presence of hard substrates and lagoonar biocenosis where samples were taken. Richness of species and biodiversity of habitats are higher in the shallow group, compared with deep one. The obtained values show greatest affinity between quadrats under man's impact, particularly due to untreated industrial and domestic discharges in the Vlora and Drini Bays (9-11b-33-29). The second subgroup comprises five quadrats (17-20-23-26-30) which have the richest number of species. Rivers affect obviously in this area. Quadrat AB of the Ionian Sea and the last shallow quadrat of the Adriatic Sea, join with this group.

The second group is composed by deep sampling quadrats. It shows very low affinity with the previous group (9,32%). All these quadrats characterized by fairly similar environmental conditions are included in soft substrate, mainly detritic, of circalitoral. The most strongly related subgroup is that of *Nephrops norvegicus - Thenea muricata* biocenosis (1-2-25-28).

Area between isobates 55-100 m deep presents as intermediate of both groups.

A more detailed evaluation of these affinities is considered premature for the moment due to the reason that further studies yielding new species from this area will influence the affinity among quadrats.

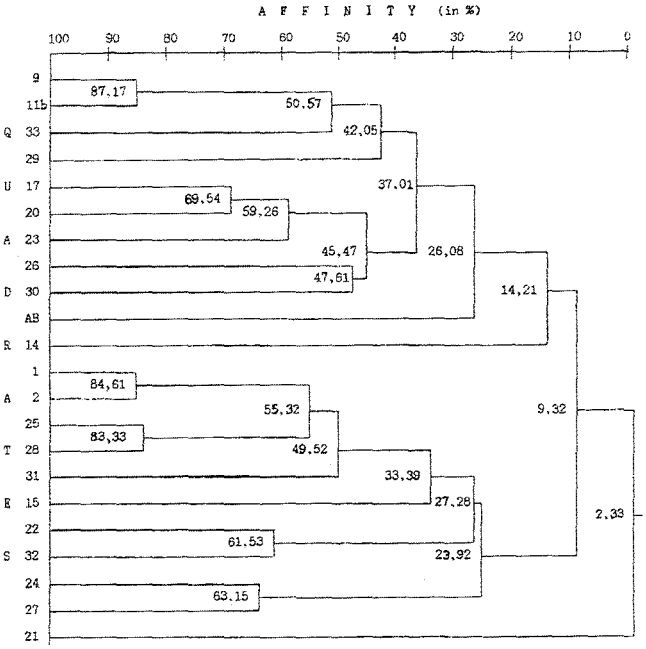


Figure 1 : Dendogram of decapods distributional affinity

REFERENCES

STEVCIC, Z., 1990. Check list of the Adriatic Decapod Crustacea. *Acta Adriat.*, 31 (1-2) : 183-274.

VASO, A. & GJIKNURI, L. 1993. Decapod crustaceans of the Albanian coast. *Crustaceana*, 65 (3) : 390-407.

VASO, A., in press, a. Preliminary data on the Crustacea Decapoda from a marine pool in Durrës (Albania - Southern Adriatic Sea). Proceedings of the 6th Congresss on the Zoogeography and Ecology of Greece and adjacent countries.

VASO, A., in press, b. The occurrence of Thoralus sollaudi (Zariquiey Cenarro) and Calcinus tubularis (Linnaeus) in the Albanian coast. Proceedings of the International Symposium on Crustacea Decapoda. 1993, Frankfurt a. M.

B

ÉTUDE FLORISTIQUE ET STRUCTURALE DE LA PRAIRIE À *CAULERPA TAXIFOLIA* DU CAP MARTIN (ALPES-MARITIMES, FRANCE)

Marc VERLAQUE et Charles-François BOUDOURESQUE

E.P. 75 CNRS, Laboratoire de Biologie Marine et d'Ecologie du Benthos, Faculté des Sciences de Luminy, F-13288 Marseille cedex 9, France

Dix années après son introduction accidentelle, l'Ulvophyceae tropicale *Caulerpa taxifolia* (Vahl) C. Agardh poursuit son extension en Méditerranée avec régularité (MEINESZ *et al.*, 1993 ; MEINESZ *et al.*, 1994). La souche acclimatée se distingue par sa large tolérance vis-à-vis de la température et de la lumière (KOMATSU *et al.*, sous presse). L'algue forme des prairies permanentes très denses et continues sur de grandes surfaces. Dans le but de déterminer les caractéristiques de ce nouveau peuplement végétal et de les comparer avec celles des phytocénoses algales méditerranéennes, nous avons effectué l'étude de la prairie à *C. taxifolia* de la région fortement envahie du Cap Martin. Les prélèvements ont été réalisés de mars à décembre 1992 (n = 4 à 6 relevés de 400 cm^2 par saison). Un site de référence sans *C. taxifolia* a été choisi dans la baie voisine de Roquebrune. Tous les relevés ont été réalisés dans les biotopes photophiles situés entre 6 et 10 m de profondeur. La méthodologie utilisée est celle exposée par VERLAQUE (1987).

L'analyse des relevés met en évidence, toute l'année, la large dominance de *C. taxifolia* et la très grande monotonie du peuplement qu'elle constitue (tab. I). Quel que soit le paramètre considéré, les valeurs obtenues sont très inférieures à celles établies dans la station de référence.

Saison	HIVER		PRINTEMPS		ETE		AUTOMNE	
Station	C.t. m (s)	Référence 6 - 10 m	C.t. m (s)	Référence 6 - 10 m	C.t. m (s)	Référence 6 - 10 m	C.t. m (s)	Référence 6 - 10 m
B C.t.g PS	13.3(3.8)	-	24.2(6.9)	-	17.9(3.0)	-	17.2(6.4)	-
h C.t, cm	10-15*	-	5-7*	-	10-15*	-	20-25*	-
N	66.5(4.1)	91-89	58.7(8.6)	111-86	38.0(5.5)	83-81	29.5(3.4)	74-66
N ≥ 0.5%	14.2(3.8)	35-40	13.0(3.0)	36-34	11.7(2.9)	39-32	5.2(1.2)	26-19
Rt , %	82(44)	366-341	51(36)	352-367	53(12)	273-208	21(16)	186-195
B A, g PS	6.8(2.4)	18-22	2.8(3.0)	22-18	3.1(2.7)	31-12	1.2(0.8)	15-4.1
H'	1.7-2.8*	3.7-3.9	1.1-2.5*	4.2-4.0	1.3-2.1*	4.7-3.8	0.5- 1.2*	3.7-3.1
J	0.36(.07)	0.56-0.61	0.30(.09)	0.61-0.63	0.31(.05)	0.73-0.60	0.16(.06)	0.59-0.51

Tab. I. Caractéristiques des relevés de 400 cm^2 de la prairie à *C. taxifolia* (C.t.), moyennes (m) et écart-types (s) sauf pour la hauteur de *C. taxifolia* (h C.t) et l'indice de diversité H' (* : minimum-maximum), comparées à celles des relevés de référence à 6 et à 10 m.

Sur la liste floristique totale, le taux d'appauvrissement du nombre de Rhodophyceae, Fucophyceae et Ulvophyceae (N) dans la prairie à *C. taxifolia* varie de 25 à 55%. Cependant, si on se limite aux taxons à Recouvrement > 0.5% (N > 0.5%), il peut atteindre 75%. Sur le plan quantitatif, le Recouvrement total (Rt) des algues autochtones est faible. Avec un taux moyen d'appauvrissement allant jusqu'à 90%, les valeurs de leur biomasse (B A) illustrent très clairement l'incidence de *C. taxifolia* sur la végétation autochtone. Les algues arbustives et gazonnantes régressent et tendent à disparaître alors que les espèces encroûtantes résistent plus longtemps. L'épiflore de *C. taxifolia* est négligeable, sauf au printemps sur les axes âgés. Cette végétation épiphyte est éliminée presque en totalité à la fin du mois de juin avec le renouvellement des axes de *C. taxifolia*. Sur le plan structural, la prairie à *C. taxifolia* présente une organisation très simple avec une strate encroûtante plus ou moins développée, une strate dressée presque exclusivement constituée par la Caulerpe et une strate épiphyte négligeable une grande partie de l'année. Ceci est illustré par les valeurs faibles à très faibles de l'indice de diversité (H' : 2.8 à0.5) et de l'Equitabilité moyenne (J : 0.36 à0.16).

Hormis *C. taxifolia*, la flore de cette prairie ne possède pas d'algues caractéristiques particulières, les espèces présentes appartenant aux phytocénoses infralittorales de mode calme. Les quelques algues dressées qui subsistent sont des espèces fortement évitées par les herbivores (*Codium, Flabellia, Halimeda, Sphaerococcus*). Le reste du cortège floristique se répartit en deux groupes, d'une part, des algues encroûtantes sciaphiles à vitalité plus ou moins réduite et, d'autre part, de petits épiphytes encroûtants et filamenteux présents essentiellement au printemps.

L'étude de l'installation de la prairie à *C. taxifolia* dans les peuplements algaux infralittoraux montre qu'elle s'effectue au détriment des espèces autochtones. L'appauvrissement maximal s'observe pendant la saison chaude (été-automne) lorsque la vitalité de la Caulerpe est optimale (croissance, production de métabolites secondaires). Tant sur le plan qualitatif que quantitatif, la prairie à *C. taxifolia* apparaît comme une phytocénose paucispécifique et peu structurée. *Caulerpa taxifolia* est la première algue introduite en Méditerranée à avoir une incidence aussi marquée sur le phytobenthos infralittoral photophile de mode calme de substrat rocheux (VERLAQUE, 1994).

REFERENCES

KOMATSU, T., A. MEINESZ et D. BUCKLES (sous presse). Données préliminaires sur l'influence de la température et de la lumière sur le développement et la croissance de *Caulerpa taxifolia* en culture, in First internation. Workshop on *Caulerpa taxifolia*, Nice 17-18 janvier 1994, C.F. BOUDOURESQUE édit., GIS Posidonie Publ., Fr.

MEINESZ, A., J. DE VAUGELAS, L. BENICHOU, G. CAYE, J.M. COTTALORDA, L. DELAHAYE, M. FEBVRE, S. GARCIN, T. KOMATSU, R. LEMEE, X. MARI, H. MOLENAAR, L. PERNEY & A. VENTURINI, 1993. Suivi de l'invasion de l'algue tropicale *Caulerpa taxifolia* en Méditerranée. Situation au 31 décembre 1992. Rapport Laboratoire Environnement marin littoral, Université de Nice-Sophia Antipolis, GIS Posidonie, Fr., 80 p.

MEINESZ, A., J. DE VAUGELAS, J.M. COTTALORDA, L. BENICHOU, J. BLACHIER, G. CAYE, P. CHAMBET, L. DELAHAYE, M. FEBVRE, S. GARCIN, T. KOMATSU, R. LEMEE, X. MARI, H. MOLENAAR, L. PERNEY et D. PIETKIEWICZ, 1994. Suivi de l'invasion de l'algue tropicale *Caulerpa taxifolia* devant les côtes françaises de la Méditerranée. Situation au 31 décembre 1993. Rapport Laboratoire Environnement marin littoral, Université de Nice-Sophia Antipolis, GIS Posidonie, Fr., 100 p.

VERLAQUE, M., 1987. Contribution à l'étude du phytobenthos d'un écosystème photophile thermophile marin en Méditerranée Occidentale - Etude structurale et dynamique du phytobenthos et analyse des relations faune-flore. Thèse Sciences naturelles, Université Aix-Marseille II, Fr., 389 p.

VERLAQUE, M., 1994. Inventaire des plantes introduites en Méditerranée : origines et répercussions sur l'environnement et les activités humaines. *Oceanologica Acta*, 17 : 1-23.

MEIOFAUNAL INVESTIGATIONS AND ANOXIA IN THE CENTRAL PART OF THE GULF OF TRIESTE (NORTHERN ADRIATIC)

Borut VRISER

Marine Biological Station, National Institute of Biology, Ljubljana, Slovenia

During 1985 a large meiofaunal sampling program was carried out in the southern and central part of the Gulf of Trieste. A poor, low–biomass macro– and meiobenthic community with low Harpacticoida diversity was found in the deepest (25–26 m) central part of the Gulf, suggesting that this could be in connection with more frequent anoxic events (1974, 1980, 1983) in this area (VRISER, 1991; VRISER & MALACIC, 1992).

Consequently a greater research interest was focused to the meiofauna of this region in the last years where another anoxia occur in September 1990. The taxonomic structure, population density and species diversity of benthic Harpacticoida were studied on 31 stations in the Gulf of Trieste in August 1985. This group was the second most numerous, following the dominant Nematodes. Higher density was detected along the coast, decreasing gradually towards the centre of the Gulf and towards open waters. Taxonomic analysis indicated 71 species and the average number was 25 species. Dominant were *Haloschizopera pontarchis, Typhlamphiascus confusus, Bulbamphiascus inermis* and *Cletodes pusillus*. Three main ecological groups were established:

1.– eurivalent, very abundant species, distributed over the whole area;
2.– stenovalent species, limited to coastal belt;
3.– stenovalent, rare species of the open waters outside of the Gulf. None of the dominant species exceeded 9%, and only 22 species exceeded 1% of total abundance. Species diversity, based on Shanon–Wiener index, increased slightly from the coast (2.6) towards the open sea (2.8) and falls to the lowest values (2.1) in the central part of the Gulf. Trellis analyses indicate three ecological provinces, following from the Gulf muds to the fine – grained sands of the open waters.

We can conclude that the main part of our investigation area is covered by one Harpacticoida community, but with some characteristics of a transition region. This community is impoverished in the central Gulf area, probably due to recurring effects of the seasonal anoxias. On the western rand of the Gulf we have found a more rich sandy bottom community of Harpacticoida, belonging to the northern Adriatic open waters.

A hypoxic bottom–water layer (22°C, salinity 37.8‰, O_2 sat. 30%) was observed in August 1990 in the central area of the Gulf of Trieste, gradually increasing in the next days to severe anoxia with catastrophic consequences for the macrobenthos community. Samples taken on 09–04–1990 on 5 locations showed a drastic decreasing of the total meiofaunal abundance, comparing them with older data from this area. Meiobenthos normalised almost entirely through the next year when we repeat our sampling on 09–17–1991. The total meiofaunal abundance returned to previous values, i.e. increased from 328 to 885 ind./10 cm^2. The density of Harpacticoida, Polychaeta, Gastropoda and Bivalvia during anoxia was nearly halved, while the abundance of Kinorhyncha and Acarina even increased. The remaining groups such as Hydroidea, Ostracoda, Ophiuroidea and Amphipoda almost vanished during anoxia, but they all reestablished again a year later.

We can conclude from this two different approaches that meiobenthos suffered badly during anoxic stress, but regenerated quantitatively quite soon. The consequences are evident probably only on a long–term scale and mostly on the species diversity level.

REFERENCES

VRISER B., 1991. Meiofauna of the southern part of the Gulf of Trieste (Northern Adriatic)II. Problems of the mesoscale spatial distribution. *Biol. vestn.* 39, 2 : 165–176.

VRISER B., V. MALACIC, 1992. Hypoxic bottom water and meiofauna in the Gulf of Trieste. *Rapp. Comm. int. Mer Medit.*, 33 : 356.

THE DISTRIBUTION OF THE SEAGRASS *POSIDONIA OCEANICA* (L.) DEL. IN THE GULF OF KOPER. PRELIMINARY REPORT

Aleksander VUKOVIC[1] and Robert TURK[2]

[1] National Institute of Biology, Marine Biological St., Fornace 41,
[2] Intercommunal Institute for Natural and Cultural Heritage Protection Piran, 66330 Piran, Slovenia

An investigation was conducted in 1993 on the size and morphological features of the only known *Posidonia oceanica* (L.) Del. bed on the west coast of the Istrian peninsula, in the Gulf of Koper, in order to be able in some further work to state stability, progression or regression of the meadow and to take proper conservation measures. According to the Natural and Cultural Heritage Protection Law from 1981 the site is bound to be protected as a natural monument.

According to some early works (BENACCHIO, 1938), the Mediterranean seagrass *Posidonia oceanica* (L.) Del. was quite common on the silted bottom of the inner part of the Gulf of Trieste but it is not mentioned almost three decades later in a work carried out on the distribution of the Zosteraceae in the gulf (SIMONETTI, 1966).

However there is still a tiny *Posidonia* meadow on the Slovenian coast between the towns of Koper and Izola (VUKUVIC, 1982). It seems to be the only remnant of the principal marine phanerogam in the Mediterranean not only in the Gulf of Trieste but along the west coast of the Istrian peninsula as well (JAKLIN, pers. com.). The area is close to the coastline and it is approximately 1 km long and only 50 m wide with the maximal depth between 2 and 4 m. The site is also next to the outfall of the Badasevica river, which is polluted with domestic and industrial waste waters.

The *Posidonia* bed is not homogeneous and it consists in numerous islands of different shape and size distributed amidst a well-formed *Cymodocea nodosa* meadow. In 1993 we started to collect data about the position and shape of the single parts of the meadow so to have a proper basis for future monitoring of its progression or decline. We also started an investigation so to find adequate sites for reintroducing *Posidonia oceanica* in the shallow waters of the Slovenian coastal sea.

REFERENCES

SIMONETTI, G., 1966. Variazioni nei popolamenti di Zosteraceae nel Golfo di Trieste durante gli ultimi decenni. *Arch. oceanogr. Limnol.*, 15, Suppl., : 107-114.
VUKOVIC, A., 1982. Pozidonia v Koprskem zalivu. *Proteus*, 44(9/10) : 345-346.

B

C

COMITÉ OCÉANOGRAPHIE CHIMIQUE

Président : Marko BRANICA
Vice-Présidents : Gustave CAUWET, Bruno CESCON

BIOGEOCHEMISTRY OF LEAD IN A COASTAL BAY OFF ALEXANDRIA

M. A. R. ABDEL-MOATI

Marine Science Department, Faculty of Science, University of Qatar, Doha P.O.Box 2713, Qatar

In addition to industrial discharge, the coastal waters of Alexandria receives huge amounts of agricultural runoff from the Nile delta lagoons as well as untreated sewage discharge from main metropolitan stations. As a consequence of the growing industrialization and human activities in recent years, the task of lead pollution in the coastal waters of Alexandria arise to be a major problem. The ultimate sink of most of metals derived through land-based sources is the semi-enclosed basins like harbors and bays surrounding the city. The present work is an attempt for evaluating the sources, behavior and fate of lead in a coastal ecosystem, to understand the degree of the metal impact on its environment. Mex bay, located west of Alexandria city, have a surface area of 19.4 km^2 and a mean depth of 10 m. The bay receives 2.2 x 10^9 m^3 y^{-1} of agricultural drainage water through Umum drain (bearing industrial wastes discharging into Lake Mariut), 0.12 x 10^9 m^3 y^{-1} of industrial water discharge from a Chlor-alkali plant as well as 1.13 x 10^9 m^3 y^{-1} from the Western harbor of Alexandria. Three factories (cement, petrochemicals and petroleum refinery) are located in the vicinity of the bay.

During 1992-1993, subsurface and near bottom sea water from 10 stations were sampled by pumping during low and high discharge periods from Umum drain. Water samples were collected in pre-acid cleaned, DDW washed and filtered sea water rinsed teflon bottles.

After filtration, Adsorptive Cathodic Stripping Voltammetry in the differential pulse mode was used for determination of labile (untreated) and total dissolved lead (acidified + UV irradiated) at pH 7.7 using 0.01 M HEPES as a buffer and 8 x 10^{-6} M oxine as chelator (VAN DEN BERG, 1986).

Labile lead values ranged from 8.6 nM Kg^{-1} near discharge points and 1.5 nM kg^{-1} seaward, constituting between 60-80% of total dissolved metal. With respect to salinity, lead behaved nonconservatively during transport from discharge points seaward showing 43-72% and 28-52% removal during high and low discharges from Umum drain. Suspended and bottom sediments were digested using the sequential method of TESSIER *et al.* (1979) followed by measurement on GFAAS. Due to the huge suspended matter discharged from landbased sources, suspended lead dominated the total metal in water constituting between 59 and 81% during low and high flow periods, respectively. Lead was enriched in Mex bay sediments sampled opposite to Alexandria Petroleum Company outfall reaching 171.2 µg g^{-1} while opposite to Umum drain, Chlor-alkali plant and Western harbor/Mex bay connection area levels were: 89.6, 34.7 and 48.2 µg g^{-1}, respectively, compared with offshore levels of 18.7 µg g^{-1}. Most of lead in sediments appeared in the organic and Fe/Mn hydroxides fractions.

Atmospheric transport is of major consideration in lead cycling. Wet and dry depositions contributed to about 2.1 ± 0.7 T y^{-1} and 0.8 ± 0.4 T y^{-1} of lead to Mex bay. However, this amount accounts for no more than 24% of total lead input to the bay through landbased sources. Sedimentation rates data (corrected for organic matter decomposition but not for resuspension) using sediment traps, deployed in the bay for two weeks, were 21.7 ± 6.3 g m^{-2} d^{-1} and 9.5 ± 1.8 g m^{-2} d^{-1} for Mex bay inshore and offshore waters, leading to an average total sedimentary flux of about 1.3 T y^{-1}.

An imbalance between the in/out fluxes of lead in Mex bay accounting to about 2.24 T y^{-1} indicate its accumulation in the water column. The standing stock of lead in the bay is 1.3 T. Phyto- and zooplankton contributed to about 0.16 ± 0.07 T and 0.3 ± 0.2 T of the lead present in the bay. Representatives of the food web showed lead accumulation in different parts of demersal rather than pelagic living organisms. Bivalves (*Donax trunculus*) and the macroalgae (*Ulva rigida*) recorded elevated accumulation factors (range 1200-4000) indicating high accumulation rates. Although the lead contents of the flesh for most common commercial fish species sampled in the bay was consistently low (< 0.3 µg g^{-1}) accumulation in liver and kidney is much higher i.e. range 10-22 and 6-13 µg g^{-1},respectively. Assessing the quantitative contribution of fish, bivalves and algae to the biogeochemical cycle of lead in the bay needs further investigations concerning their stocks and periodicity.

REFERENCES

TESSIER A.; P. CAMPBELL and M. BISSON (1979). *Analytical Chemistry*, 51 (1): 844.

VAN DEN BERG, C.M.G. (1986). *Journal of Electroanalytical Chemistry*, 215 : 111.

BENTHIC RECYCLING OF PHOSPHORUS IN THE COASTAL WATERS OF ALEXANDRIA

M. A. R. ABDEL-MOATI

Marine Science Department, Faculty of Science, University of Qatar, Doha P.O.Box 2713, Qatar

Since the cessation of the Nile flood by the erection of Aswan High Dam completed in 1965, the discharge of nutrients through the Nile to the S.E. Mediterranean has drastically declined. Landbased sources including agricultural runoff from coastal lagoons, industrial and sewage discharges substituted, with a lower magnitude, the Nile water discharge. However, the productivity of the coastal waters are still dramatically affected. Most of the recent studies (DOWIDAR and ABDEL-MOATI, 1990), indicated that phosphorus is the key limiting nutrient regulating such productivity.

Being an important component of the biogeochemical cycles and flow of energy, benthic communities become progressively an important partner in marine ecosystems. Examining the functional aspects of such communities is an attempt to understand their active role in marine environment, especially the regeneration of nutrients. The purpose of the present study was to quantify the nutrient regeneration role of benthos using *in situ* measurements of net sediment/water flux of phosphorus.

Three locations were selected in the coastal waters of Alexandria during the period July - December 1992 (depth range 5-7 m), for measuring sediment/water nutrient flux. Quantitative samples were taken to characterize the communities while sediment samples were analyzed for grain size and organic matter. Station A was characterized by coarse sand and amphipods dominating the biotic community (organic matter 1.5%). A sandy silt bottom characterized station B (organic matter 4.5%) dominated by polychaetes and bivalves. Station C was on a sandy silt base (organic matter 4.1%) dominated by hatchet foot pelecypods.

Net exchanges of dissolved substances across the sediment/water interface was determined by entrapping a known water volume exposed to a known sediment area in a bottom chamber and monitoring phosphorus concentrations over time. Three opaque PVC pipe cut chambers 120 cm long x 30 cm diameter having a bottom area : volume ratio of 90 cm^2 l^{-1}, were carefully placed in each location by SCUBA divers. Simultaneously, dark bottles filled with bottom waters were incubated beside the chambers for correction of oxygen and nutrient changes caused by plankton inside the chambers.

The mean oxygen uptake by sediments and associated benthos was 45.6, 38.9 and 40.1 mg m^{-2} h^{-1} for different locations. The range for the *in situ* inorganic phosphorus flux in the three stations was -0.63 to 47.98 (av. 16.4 ± 8.5), -2.44 to 36.3 (av. 8.1 ± 6.3) and -10.7 to 18.4 (av. 5.3 ± 4) µM m^{-2} h^{-1} at the sampling sites, respectively, with an overall mean of 10.3 ± 4.8 µM m^{-2} h^{-1}. Replicate variations between chambers at the same site did not exceed 10%. Phosphorus release at all stations showed a highly significant correlation with temperature and oxygen uptake giving rise to the regression equations: P flux = -10.4 + 1.66 T ($r = 0.89$, $p < 0.01$) and P flux = -6.23 + 0.03 O_2 uptake ($r = 0.69$, $p < 0.05$). The slope and intercept for station A were significantly greater ($p < 0.05$) than B and C, while the intercepts but not the slopes of B and C were significantly different ($p < 0.05$). The overall correlation between released phosphorus and that present in the overlying water was positive ($r = 0.73$) in the whole area indicating that sediments are not buffering phosphorus concentrations in water. Organic matter content of sediments showed an association with increased phosphorus fluxes. The relationship between phosphorus release at the three localities with numerical abundance appeared to be stronger than with biomass.

The mean O:P ratio (atoms) for the three studied locations was 192 ± 86, 385 ± 190 and 421 ± 292, respectively. This ratio generally increased with decreasing temperature showing a significant ($p < 0.05$) O:P ratio on temperature.

Due to the intermittent appearance of anoxic conditions in some areas off Alexandria coast, specially during summer time, a long term measurement (96 hr) at station B during July showed an initial increase in phosphorus concentration after which it tended to level off as the concentration gradient between interstitial and overlying waters decreased. When DO become near depletion (0.8 ml l^{-1}), phosphorus release rate increased gradually towards the end of the experiment reaching 108 µM m^{-2} h^{-1}. The sudden increase resulted as response to anoxia indicating nutrient desorption to the overlying water.

Compared to previous estimates in area B performed using lab experiments (DOWIDAR *et al.*, 1990), the present phosphorus fluxes were nearly 10 times higher than previous records. Consequently, it seems likely that the contribution of benthic fluxes during maximum regeneration can supply a substantial amount of phosphorus requirements of phytoplankton. Further evidences of benthic releases indicating a phytoplankton bloom are needed.

Although discrepancies regarding considerations of bottom currents and sediment resuspension leading to underestimates of actual fluxes, results must be regarded as a preliminary attempt to assess the relative importance of benthic regeneration in the area.

REFERENCES

DOWIDAR.N. and ABDEL-MOATI M.A.R., 1990. *Acta Adriatica*, 31 (1/2):37-46.

DOWIDAR.N., ABDEL-MOATI M.A. ABOUL-KASSIM T. and EL-NADY F., 1990. *Rapp. Comm. int. Mer Medit.*, 32 (1):42.

C

PHYTOPLANKTON PIGMENT/CARBOHYDRATE RELATIONSHIPS IN THE NORTHERN ADRIATIC

Marijan AHEL[1], Senka TERZIC[1], Alenka MALEJ[2] & Robert PRECALI[3]

[1]Center for Marine Research Zagreb, Ruder BoskovicInstitute, Zagreb, Croatia
[2] Marine Biological Station Piran, Institute of Biology, Univ. of Ljubljana, Slovenia
[3] Center for Marine Research Rovinj, Ruder Boskovic Institute, Rovinj, Croatia

Wide variety of biochemical compounds, including proteins, lipids, carbohydrates and photosynthetic pigments, have been used to study biological situation in estuarine and coastal environments. Determinations of chlorophyll and carotenoid pigments in the marine environment have proved to be particularly useful for providing additional information about the chemotaxonomic composition of phytoplankton and species specific distribution of phytoplankton biomass (BARLOW *et al.*, 1993). On the other hand, recent investigations have shown that carbohydrates represent a major pool of dissolved organic carbon in the oceans. Moreover, polysaccharides are thought to play an important role in formation of larger organic aggregates. Large-scale gelatinous mucus aggregations observed in the Adriatic Sea consisted mainly of polymeric carbohydrates (POSEDEL and FAGANELI, 1991). In addition, it was suggested that copepod grazing can strongly be inhibited by diatom carbohydrate-like exudates (MALEJ and HARRIS, 1993). The aim of this study was to investigate the relationships between the phyto-plankton biomass and concen-trations of carbohydrates (CHO) in the northern Adriatic.

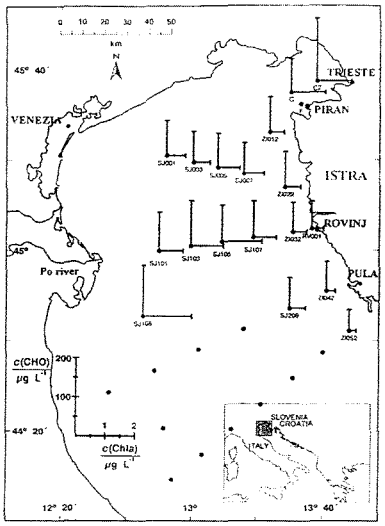


Figure 1. Annual mean Chl a and CHO concentrations in the water column of the N. Adriatic in 1992.

Sea water samples for phytoplankton pigment and carbohydrate determinations were collected on several stations (Fig. 1) in approximately monthly intervals during 1992 at standard oceanographic depths (0, 5, 10 and 20 m). After filtration through a Whatman GF/F filter pigments were determined by reversed-phase HPLC according to a modified method by Mantoura and Llewellyn (BARLOW *et al.*, 1993), whilst total CHO were determined from unfiltered samples using the standard phenol-sulphuric method. Distributions of the annual mean concentrations of both chlorophyll a and total CHO in the top 10 m of the sea water column (Fig. 1) indicate strong influence of the river inputs on the observed concentration levels with maxima recorded close to the freshwater plume of the Po River and in the Gulf of Trieste.

Since hydrographic conditions in 1992 were not particularly favourable for the formation of a high phytoplankton biomass compared with some previous years the concentrations of CHO were rather low (< 0.5 mg/l). Nevertheless, a comparison of seasonal fluctuations of phytoplankton biomass and CHO concentrations in the Gulf of Trieste (Fig. 2) suggested their positive correlation in some seasons. A pronounced CHO spring peak in the surface layer was accompanied by a concomitant peak of fucoxanthin (fuc), a characteristic accessory pigment from diatoms. Similar situation was observed in the bottom layer. By contrast, seasonal peak of 19'-hexanoyloxyfucoxanthin (hex), accessory pigment characteristic of Prymnesiophytes, was not followed by similarly enhanced concentrations of CHO. A linear regression analysis (log-lin) between the diatom counts and total CHO concentrations showed a week but significant correlation between the two parameters (r = 0.43). This suggested that not only phyto-plankton biomass con-centration but also its physiological status played an important role in determining CHO levels in the northern Adriatic.

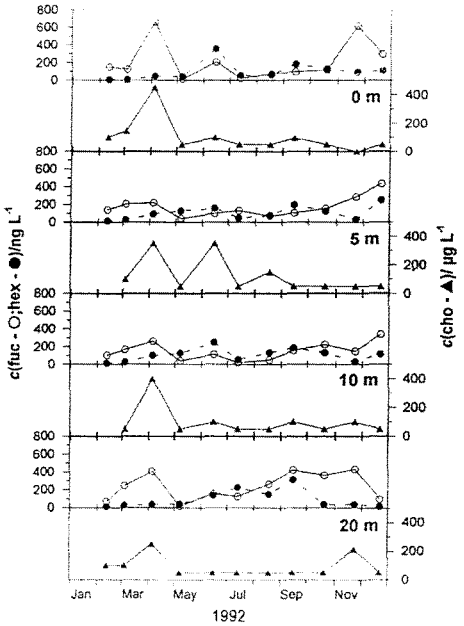


Figure 2. Seasonal fluctuations of CHO and accessory photosynthetic pigment concentrations in 1992 in the Gulf of Trieste.

REFERENCES

BARLOW R.G., MANTOURA R.F.C., GOUGH M.A. and FILEMAN T.W., 1993. Pigment signatures of the phytoplankton composition in the northeastern Atlantic during the spring 1990 diatom bloom. *Deep-Sea Res.* II, 40:459-477.

MALEJ A. and HARRIS R.P., 1993. Inhibition of copepod grazing by diatom exudates: a factor in the development of mucus aggregates? *Mar. Ecol. Prog. Ser.*, 96 : 33-42.

POSEDEL N. *AND* FAGANELI J., 1991. Nature and sedimentation of suspended particulate matter during density stratification in shallow coastal waters (Gulf of Trieste, northern Adriatic) *Mar. Ecol. Prog. Ser.*, 77 : 135-145.

AN ESTIMATE OF PELAGIC AND BENTHIC OXYGEN CONSUMPTION AND NUTRIENT REGENERATION RATES FROM ELNA DATA IN THE ADRIATIC SEA

Vica BANZON and Tom Sawyer HOPKINS

MEAS/NCSU, Raleigh, NC, USA

Oxygen and nutrient fluxes as determined from sediment core incubations reflect respiration and nutrient regeneration rates in the seabed. Rates inferred from a temporal series of hydrographic profiles of oxygen and nutrients instead represent the result of both pelagic and benthic processes. Both types of data are available from two ELNA cruises (June-July 1993) in the Adriatic sea, thus providing an opportunity to compare rates of water column versus benthic respiration/regeneration. Bottom sediments, collected by a boxcorer, were subsampled in triplicate and the subcores were incubated onboard. All boxcore stations were deeper than 25 m and included the Po area, the Italian coast from Ravenna to Ancona, and the Jabika Pit. Oxygen and nutrient (SiO2, NH1, NO3, NO2) concentrations from the incubation cores were monitored over a 1-2 day period. In each case, the rate of change was determined by a linear fit . The rates obtained tended to be comparable or lower than published values (GORDIANI *et al.*, 1992), but most of these previous *in situ* measurements were made at shallower depths. The ΔSi:ΔO and ΔSi:ΔN ratios showed no consistent trend suggesting that the recycling of silicate is decoupled from the other nutrients, as noted earlier by DEGOBBIS and GILMARTIN (1990). In many cases, the ΔO:ΔN ratio deviated from the Redfield ratio, especially in the Po area. For the water column data, we selected a number of hydrographic stations in the vicinity of the boxcore stations (within a ~ 10 km radius). Volume integrations for the lower layer were made, and rates were determined by difference. Stoichimetric ratios for the changes are compared with those from the incubations. The importance of pelagic vs. benthic processes in recycling of organic matter in the Northern Adriatic is discussed.

REFERENCES

DEGOBBIS D. and GILMARTIN M. , 1990. *Oceanol. Acta*, 13 (1) : 31-45

GIORDANI P. et al., 1992. In : Volleweider R. A., Marchetti R. and Viviani R. (eds), "Marine Coastal Eutrophication, Elsevier, New York, pp. 251-275.

ELECTROANALYTICAL METHODS AND A NEW IN SITU SAMPLER FOR THE CHARACTERISATION OF PORE WATERS OF SEDIMENTS OF THE LAGOON OF VENICE

Andrea BERTOLIN, Gian Antonio MAZZOCCHIN and Paolo UGO

Department of Physical Chemistry, University of Venice
Calle Larga S. Marta 2137, 30123 Venice, Italy

The understanding of the early diagenesis processes in superficial sediments of transitional environments is particularly important in order to know the effect and fate of toxic pollutants discharged in the environment. Precious information helping in the solution of such a complex problem can be drawn by continuously monitoring of pore waters. Sampling methods providing realiable samples and analytical techniques with satisfactory precision and accuracy need to be available. Moreover, since a wide range of analyses are necessary, a good advantage could derive from using analytical techniques, preferably with speciation capabilities, able to give concentration information on a variety of substances.

Among other analytical methods, electroanalysis is increasing its importance in ecosystem studies, particularly in chemical oceanography, being many substances of relevancy in the characterization of marine waters electroactive. Moreover, electroanalysis have the advantage that measurements can be carried out directly in crude marine waters with few or none chemical pre-treatments, without altering natural equilibria.

On the other hand, as far as marine pore waters is concerned, several problems arise from the availability of suitable sampling methods and apparatus able to avoid alterations of chemical equilibria and in the natural composition of the sample.

In this communication we describe a new prototype *in situ* pore water sampler which allows temporal sampling of pore-water from intertidal sediments. The system consists of a nylon device provided with regularly spaced chambers, double filtering ports and pipes for sample recovering. The field use of this apparatus for determining sulfur species and heavy metals in pore-waters is decribed; a satisfactory agreement between data gained by using the proposed *in situ* sampler and by core-squeezing in proper experimental conditions is obtained.

The concentration profiles for reduced sulfur species, iron and manganese are determined by cathodic stripping voltammetry, while the concentration of copper lead and cadmium are measured by anodic stripping voltametry. Moreover the application of new electroanalytical methods such as ion exchange voltammetry at polymer coated glassy carbon electrodes, is exploited for determining dissolved mercury.

The peculiarities and the flexibility of coupling of the here described sampling apparatus with electroanalytical methods allow to study seasonal variations and cycling as well as changes in the composition sampled in mud flats and marsh lands.

Finally, we discuss the relevance of the obtained data to understand the influence of equilibria between heavy metals and reduced sulfur species to the mobilization of the pollutants.

THE INFLUENCE OF ORGANIC SUBSTANCES ON THE ZETA POTENTIAL OF CALCITE

Jasenka BISCAN and Neda VDOVIC

Center for Marine Research, Ruder Boskovic Institute,
Bijenicka 54,41000 Zagreb, Croatia

Suspended matter in river waters is the important transport mean for some contaminants, because of the mutual interaction of adsorbing mineral particles and dissolved organic or inorganic species. The attraction forces which govern adsorption processes depend on the properties of adsorbates and adsorbents, and on some physico-chemical parameters (pH, salinity, temperature). For that reason the fate of contaminants is decided in estuarine regions where those parameters change rapidly and cause :

1- adsorption which leads to flocculation and sedimentation and removal of contaminants from the water column (SONDI *et al.*, 1994);

2- remobilization of already adsorbed material which can be carried further into the sea or become biologically available (ELBAZ-POULICHET *et al.*, 1982).

The aim of our work was to study the behavior of suspended particles in relation to changes of pH, salinity and organic matter concentration encountered in estuarine regions. For that purpose we used calcite (pure chemical precipitate) as one of representatives of mineral compounds in natural estuarine and sea waters of Adriatic region and studied its behavior in the transition from riverine to seawater. As an indicator of changes we used zeta potential (ζ, mV), a parameter calculated from the results for electrophoretic mobility (epm). Epm measurements were made with an automated apparatus for microelectrophoresis, PenKem 3000.

The results have shown that in initial solution (10^{-3} mol dm^{-3} NaCl representing river water) model minerals show different values of zeta potential - not only in range, but also in sign. Namely, opposite to all other minerals, calcite shows positive value for zeta potential in pure NaCl solution. Titration of the initial suspension with artificial seawater (ASW) slightly reduced zeta potential of all samples, but charge reversal of calcite was observed only after titration with natural seawater (Table 1).

Table 1: Zeta potential of model minerals in different solutions

Model mineral	10^{-3} mol dm^{-3} NaCl	ASW	NSW
calcite	+ 20 mV	+ 5 mV	- 10 mV
quartz	- 50 mV	- 7 mV	- 12 mV
montmorillonite	- 30 mV	- 12 mV	- 15 mV

Where is the origin of the negative zeta potential in NSW? BISCAN and DRAGCEVIC (1993) found that the reasons could be either amorphous Fe and Mn oxides in calcite sample, or adsorbed organic material. Since the seawater contains a wide variety of organic substances our aim was to find which type of organic matter can reverse the positive charge of calcite into a negative. For that purpose we exposed calcite to the influence of some organic substances (fulvic, citric, oxalic and some saturated fatty acids - propionic, capric and myristic) in 10^{-3} mol dm^{-3} NaCl and artificial seawater (ASW). Fulvic acid caused the charge reversal at a concentration of about 0.4 mg dm^{-3}, and citric acid caused the reversal of charge at about 5x10-5 mol dm^{-3}. No effect on the zeta potential was observed either for oxalic acid or for the saturated fatty acids in the concentration range between 5x10-7 and 10-4 mol dm^{-3}. The results obtained revealed some organics which can reverse the positive charge of calcite, but they also showed that this is not just the question of the type of organic matter but also the question of concentration. Studies of the assessment of the adsorption of these organics at the calcite surface are in progress.

REFERENCES

J. BISCAN and D. DRAGCEVIC, 1993. Electrokinetics of model mineral suspensions. *Mar. Chem.* 43: 127-135.

F. ELBAZ-POULICHET, W.W. HUANG, J. JEDNACAK-BISCAN, J.-M. MARTIN and A.J. THOMAS, 1982. Trace metals behaviour in the Gironde estuary: the problem revisited. *Thalassia Jugosl.* 18 (1-4): 61-95.

I. SONDI, M. JURACIC, E. PROHIC and V. PRAVDIC, 1994. Particulates and the environmental capacity for trace metals. A small river as a model for a land sea system: the Rasa River estuary. *Sci. Total Environ.* 155: 173-185.

DEVELOPMENT OF ELECTROANALYTICAL INSTRUMENTATION FOR PHYSICO-CHEMICAL CHARACTERIZATION OF TRACE METALS IN THE MARINE ENVIRONMENT

Marko BRANICA

Center for Marine Research Zagreb, Rudjer Boskovic Institute, P.O. Box 1016, 41001 Zagreb, Croatia

In the framework of EUREKA - EUROMAR Project, the ELANI EU-493 project entitled: Electroanalytical Instrumentation Development for Physico-Chemical Characterization of Trace Metals in the Marine Environment has started in 1989, with the following objectives:

- development of a new electrochemical instrumentation for the
- direct electroactive trace metal determination
- metal complexing capacity determination
- determination of correlation of different species of trace metals (of natural and anthropogenic origin) and their physico-chemical properties in the aquatic environment.

The intention of this project is to give a contribution in elucidating of the appropriate water samples treatment, taking into account the entire process from sampling of the natural waters to the analytical treatment, including procedures for determination and final evaluation of relevant information from the experimentally obtained data. Field observations and theoretical and experimental laboratory work is devoted to the development of sensitive and specific instrumentation for establishing the governing mechanisms and the influence of various parameters on the fluxes and transformations of different forms of trace metals on the natural concentration level as well as on the level of metal pollutants in the European continental and marine aquatic environment.

The cooperation between the laboratories and a firm from the countries participating in this project (University of Liverpool, Liverpool, UK; The firm Eco-Chemie, Utrecht, The Netherlands; Forschungszentrum Juelich, Juelich, Germany and Rudjer Boskovic Institute, Zagreb, Croatia), resulted in a construction of a prototype of a portable instrument "ELANI-1", which will be described.

The results obtained for the determination of electroactive trace metals will be demonstrated in the case of Cu, Pb and Cd as well as the corresponding possibilities of metal complexing capacity determination in the model solutions as well as in the samples from the marine environment.

The development foreseen in the near future will be also discussed.

STATISTICAL ANALYSIS OF CHEMICAL AND PHYSICAL QUALITIES OF THE SOUTHERN ADRIATIC SEA WATER

Nicola CASAVOLA[1], Giovanni MARANO[1] and Costantino MASCIOPINTO[2]

[1] Laboratorio di Biologia Marina di Bari. Italia

[2] Istituto di Ricerca sulle Acque del C.N.R, Reparto di Bari. Italia

Since 1984 the Laboratory of Marine Biology in Bari has realized 29 seasonal cruises in the Low Adriatic Sea, to evaluate the biomass of small semipelagic fish, *Sardina* and *Engraulis*, and at the same time survey the waters' main physical chemical values (CASAVOLA *et al.*, 1984; CASAVOLA *et al.*, 1986).

Sampling has been carried out on a network of 20 stations over 5 transects, at a distance of 30 miles between each other, from Gargano to Otranto, using 5-litre NIO sampling bottles. The measurements of thermal, saline and oxygen stratifications have been carried out by means of an Idronaut probe, while transparency has been measured on the spot with the Secchi disc.

In the laboratory, concentrations of ortho-phosfate (PO4), total phosphorus (PT), ammonia nitrogen (NH3), nitrite nitrogen (NO2), nitrate nitrogen (NO3), total inorganic nitrogen (NI) and chlorophyll-a (CHLa) have been determined in each water sample according to the STRICKLAND & PARSONS methods (1972). It was realized that the coast waters in the Low Adriatic Sea present highly limited nitrogen and phosphorus concentrations, considerably inferior to the ones verified in other Adriatic coast areas. Therefore, analytical data once again evidence an oligotrophy.

To obtain a homogeneous chemical-physical classification of sea water samples a statistical elaboration on observed parameters (i.e. 12 parameters for each group of measurements) has been carried out. The data set used for the statistical analysis is composed of the seasonal mean values of 8 years measurements. The data refer to twenty stations and as there was a seasonal sampling for each station, the total number of data is eighty.

The statistical hierarchical agglomeration between similar groups has not been carried out because of the position of the stations, along the Adriatic coast of Puglia, is not random and the measured data are not enough. However, the Cluster analyses showed that among the sampling stations there are 2 groups of measurements with values more elevated than the other groups. In particular these 2 groups of measurements, carried out during the winter, are referred to the nutrients and the chlorophyll-a measured, and are located at the arrival and departure points of the sea current in the Gulf of the Manfredonia.

On the contrary the results of the factor analysis have been very significant. As well known this analysis is a statistical technique that allows a projection on principal axes of many independent variables that characterize the physical phenomenon. This procedure allows an easy representation in principal planes of the influence of each variable on the examined phenomenon. In this way the factor analysis attempts to represent relationships among sets of interrelated variables by a smaller set of relatively independent and interpretable, but not directly observable factors.

Thus, first of all, the results of this analysis have shown that the classification of quality of sea water can be considered a two dimensional problem. The two principal components, identified by means of several extraction methods (PC, PAF, ALPHA, ULS, ML, etc.) are related to the "biological activity" and to the "environmental conditions". The first component represents the nutrients in the sea water and includes all parameters of the "primary production" and of the "eutrophic product", that is the chlorophyll-a. The second component represents the physical and chemical conditions in which the biologic activity takes place, that is the temperature, the dissolved oxygen, the salinity, the transparency, etc.. The coefficients of the factors have been evaluated using the regression method applied on the standardized variables.

Using the principal Component extraction method (PC), the variance explained by each factor (i.e. eigenvalue) is 6.13 and 1.99 which are respectively 51% and 16% of the total variance.

Rotation of factors has been done to achieve a simple structure of them. The varimax method has been used to minimize the number of variable that have high loadings on the factors.

The final result of factor analysis shows that the characteristic of the quality of the Southern Adriatic sea water can be defined by 2 factors. The first one describes the biological activity and the second describes the environment conditions. Moreover each of the parameters NI, NO3, PO4, CHLa o PT is highly significant to explain the biological activity, while the temperature is the parameter that better describes the environmental conditions of the biological activity.

REFERENCES

CASAVOLA N., DE MARTINO L., MARANO G. & SARACINO C., 1984.- *Acc. Pugl. Sci.*, 41: 3-15.

CASAVOLA N., DE MARTINO L. & MARTINO G., 1986.- *Nova Thalassia.*, Suppl.3: 655-666.

STRICKLAND J.D.H. & PARSONS T.R., 1972.- *Bull. Fish. Res. Bd. Can.*, 167: 1-312.

INPUTS OF PHOSPHORUS AND NITROGEN INTO THE MEDITERRANEAN SEA BY THE RHONE RIVER. VARIABILITY DURING THE LAST 20 YEARS

B. COSTE and P. RAIMBAULT

Centre d'Océanologie de Marseille. Fac. des Sciences de Luminy. 13288 Marseille, France

Continental inputs of phosphorus and nitrogen into the Mediterranean Sea are connected to several features :
- 50% of the primary productivity in the dilution area (Gulf of Lions) are supported by phosphate and nitrate inputs by the Rhone river (COSTE, 1974).
- the continental inputs explain, for a part, the concentrations of phosphate and nitrate in the DEEP WATER OF THE MEDITERRANEAN SEA (MC GILL, 1968; BÉTHOUX AND COPIN-MONTÉGUT, 1986; COSTE *et al.*, 1988). Indeed, input (Atlantic water and river water) and output (Mediterranean Sea water) on the straits of Gibraltar are equilibrated. Modifications in the amounts of phosphorus and nitrogen by river discharges could contribute to modifications in the deep water concentrations. In this paper, we want to present Rhone river data obtained since 1968 and, more particularly, some recent data (1989 and 1990) to discuss their temporal variability.

Water input. The Rhône river is the main contributor to river water input into the western mediterranean basin. Its mean flow is 1700 $m^3.s^{-1}$; Ebro river is 200 $m^3.s^{-1}$, Arno river 103 $m^3.s^{-1}$, Tiber river 234 $m^3.s^{-1}$ (MARTIN and SALIOT, 1992). The Rhône river flow is very irregular: it varies from 500 to 13000 $m^3.s^{-1}$ and it presents a seasonal variability (maxima in autumn and winter and minima in summer)as well as an interannual variability (Table I).

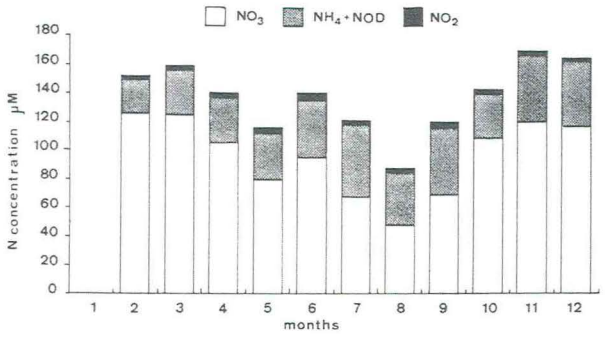
Table 1. main data concerning the Rhône river flow and nutrient concentrations during the 4 years studied.

Year		1968	1984	1989	1990
Mean annual flow (m3s-1)		1 829	1 678	1 061	1 301
Nutrient inputs	N	54 952	53 458	48 591	56 854
(tonnes.y-1)	P	4 064	6 454	4 712	5 077
Mean annual concentrations	N	68	72	104	98
(ml l-1)	P	2,2	3,8	4,4	3,9

Nutrient concentrations. Along the year, the nutrient concentrations vary within a ratio factor lower than 1 to 4. Nitrate are between 50 and 160 µM and phosphate between 2 to 9. These results are in good agreement with those reported by MEYBECK (1982). In 1984, we measured different forms of nitrogen compounds (fig. 1). Nitrite concentrations vary all along the year from 1 to 5 µM, ammonium plus dissolved organic nitrogen (DON) from 20 to 60 µM and nitrate from 50 to 160 µM. Some separated measurements for ammonium and DON show that DON is about 50 to 70% of the total. Then nitrate is the main source of nitrogen input but ammonium and DON have to be taken into account in estimating a mediterranean nitrogen budget.

Seasonal variability in the nutrient concentrations. Maxima concentrations in winter (November to March) and minima in summer (June to September) appear to be a general rule for nutrients (COSTE, 1974). For instance, nitrate concentrations show such a scheme in 1984 (fig. 1). Some exceptions, due to perturbations in the flow of the Rhone river, can be encountered. Such a seasonal cycle does not appear for the other forms of nitrogen. Nitrite does not show a significant seasonality. Ammonium+DON present only a slight seasonal signal with weak maxima in summer and autumn.

Figure 1: Variations in the concentrations of the different forms of nitrogen compounds along 1984.



Seasonal variability in the nutrient inputs. We can compute the nutrient inputs (tonnes.$year^{-1}$) from the values of the flow and those of the nutrient concentrations. The obtained results are characterized by a high seasonal signal because the higher concentrations values are concomitant to those of the flow. Thus the nutrient inputs are maxima at the beginning of the year and minima in summer with a ratio of 1 to 10.

Interannual variability. Table I presents the main features of flow and nutrient input for 4 years. It shows that: 1/ annual nitrate input is rather constant since 1968. Deviations from the mean value are less than 5%. Phosphate annual input is more variable and the recent data are 20% higher than the 1968 data. 2/ the mean concentrations of these nutrients are 50 to 70% higher in 1989 and 1990 than in 1968.

These results lead us to conclude that :
- a high seasonal signal characterizes the nutrient inputs all along the last 20 years. It is due to simultaneity of higher concentrations and higher flow values.
- the annual nitrate input has not varied significantly since 1968. Such a result has to be compared to variability of the mean annual values of the flow. The more recent data of the flow are 30% lower than the earlier. It seems that the low variability of the nitrate input could be explained by the flow variability.
- the variations of phosphate input could be explained by the flow variability but also by an increase in anthropogenic activity.

REFERENCES

BÉTHOUX J.P. & COPIN-MONTÉGUT G., 1986. Biological fixation of atmospheric nitrogen in the Mediteranean Sea. *Limnol. Oceanogr.*, 31: 1353-1358.
COSTE B., 1974. Rôle des apports nutritifs minéraux rhodaniens sur la production organique des eaux du Golfe du Lion. *Téthys*, 6: 727-740.
COSTE B., LE CORRE P. & MINAS H.J., 1988. Re-evaluation of the nutrient exchanges in the Strait of Gibraltar. *Deep-Sea Res.*, 35: 767-775.
MARTIN J.M. & SALIOT A., 1992. Bilan des apports fluviatiles et atmosphériques d'éléments et composés chimiques en Méditerranée occidentale. pp. 61-66, *in* : 3èmes Rencontres de l'Agence Régionale pour l'Environnement Provence-Alpes-Côte d'Azur, 24-27 Septembre 1991.
MCGILL D.A., 1969. A budget for dissolved nutrient salts in the Mediterranean Sea. *Cah. océanogr.*, 21: 543-554.
MEYBECK M., 1982. Carbon, nitrogen, and phosphorus transport by worlld rivers. *Amer. J. Sci.*, 282: 401-450.

GEOCHEMICAL, SEDIMENTOLOGICAL AND MINERALOGICAL DATA SEDIMENTS OF THE NORTHERN AND CENTRAL ADRIATIC : A MULTIVARIATE STATISTICAL ANALYSIS

A.DE LAZZARI, M.MISTOLATO, G.RAMPAZZO AND C.TURETTA

Department of Environmental Sciences, Geo-Mineralogical Section, University of Venice. Calle Larga S.Marta 2137, 30123 Venice, Italy

Several studies of the Adriatic Sea shelf have already been carried out on recent and ancient sediments. The present interest, regarding the study of sediments, is connected with the cognitive research and with the environment protection, which needs, in the complexity of the situation, a natural solution, efficacious and rational. The work, shortly described in this note, has been conducted on recent superficial sediments (thickness from 0-5 cm) of the Adriatic Sea. Sediments samples, for a total of 33, have been drawn in the Summer 1990, along 7 transversal transepts in 33 stations in international waters of the northern Adriatic Sea, between the Lagoon of Venice and the junction Gargano-Tremiti-Lagosta.

The following investigations were conducted on the collected materials:
- geochemical : determination of atomic absorption spectrometry of the major (Si, Al, Fe, Mg, Ca, Na e K), minor (Ti, P e Mn) and trace (Zn, Pb, Cd, Cu, Cr, Ni, Co e V) elements;
- mineralogical : definition of the essential qualitative mineralogical composition (light and heavy minerals) by x-ray diffraction analysis, and the study by microscope of some representative samples. The quantity of carbonates was determined by gas-volumetric method.
- sedimentological : determination of the granulometric distribution in the three fractions (sand, silt, clay), and S.S.A. (specific surface area).

A comparative examination of the results obtained by the various investigations has followed, even through a descriptive and multivariate statistical elaboration, which permitted to obtain informations and important results and has pointed out, among the variables, many correlations often difficult to be recognized, operating separately. Experimental data obtained from the various investigations, together with the values of some organic pollutants (PCB, PAH, DDT) associated to particulate input of the several rivers (Po and Adige in particular) in the studied area, have been elaborated by factor analysis (Q-Mode) and analysis of clusters.

The statistical elaboration has allowed to
- identify and define the relationship among determined variables,
- verify the type of connection among particle-size analysis, trace metals and pollutants of organic origin,
- evidence "new connection" among variables (Cd connected to the organic substance; PAH, PCB, DDT, connected to the organic substance and to K),
- synthetize and compare the results obtained with the distribution drawn applying the most classic method of classification. The application of the multivariate statistical analysis, has been preceded by a preliminary analysis of data and of their distribution kind through particular graphic presentation and/or semi-graphic (box-and-whisker plot; stem and leaf display) and the use of non-parametric and robust tests.

The present work must be seen as the starting point of a wider and detailed work of the analysed area.

C

DIRECT DETERMINATION OF DISSOLVED URANYL(VI) IN SEAWATER BY CATHODIC STRIPPING VOLTAMMETRY

Renata DJOGIC and Marko BRANICA

Center for Marine Research Zagreb, Ruder Boskovic Institute,
P.O.Box 1016, 41001 Zagreb, Croatia

The dissolved uranyl(VI) is present in seawater at an almost constant concentration of 3.3 µg/l (KU *et al.*, 1977). It has been accepted that the anionic uranyl(VI)-tricarbonato complex $UO_2(CO_3)3^{4-}$ is the predominant chemical form of dissolved uranyl(VI) in seawater (DJOGIC *et al.*, 1986). As a consequence of ion pairing reactions, the complex could be more precisely described as $Na_2(UO_2(CO_3)_3)^{2-}$. At an elevated hydrogen peroxide concentration (in euphotic zone) uranyl(VI) appears partially as a mixed uranyl-dicarbonato-hydrogenperoxo complex $UO_2(CO_3)_2(HO_2)^{3-}$ (DJOGIC and BRANICA, 1991). This study has been performed to develop the simple electrochemical procedure for quantitative determination of uranyl(VI) in natural seawater samples.

Solubilities and mobilities of various uranyl(VI) species which exist under the nuclear waste disposal conditions, as well as their adsorption on soil particles and their leaching into waters are very important environmental problems. Because of this, the need of a direct method to determine the concentration of uranyl(VI) in natural waters is of great prominence. To accomplish this, it is neccessary to clarify the mechanisms of uranyl(VI) physico-chemical processes in natural water.

Negative highly charged ion of uranyl(VI)-tricarbonato complex is not adsorbed on the solid particles and sediments in marine environment. In accordance with its solubility, adsorption at the electrode surface is not possible. To transform this species into an adsorbable one, the destruction of carbonato complexes and formation of uncharged uranyl species is needed. This process is achieved according to the following equations.

$$UO_2(CO_3)_3^{4-} + 6\,H^+ \xrightarrow{pH = 4} UO_2^{2+} + 3H_2O + 3CO_2$$

$$UO_2^{2+} \xrightarrow{pH = 6.5} UO_2(OH)_2^0 \xrightarrow{2\,OH^-} *N_2$$

** by bubbling N_2 carbon dioxide was eliminated from sample in the electrochemical cell.*

This uncharged hydrolyzed uranyl(VI) species is favored to be adsorbed at the electrode surface (DJOGIC and BRANICA, 1994). Consequently by this procedure uranyl(VI) is transformed in such a way that its concentration can be determined by square wave cathodic stripping voltammetry. The standard addition method (Fig.1), can be successfully applied at very low concentration such as 10^{-8} mol l^{-1} in which uranyl (VI)-ion is present in seawater. The results from different stations of seawater samples will be discused.

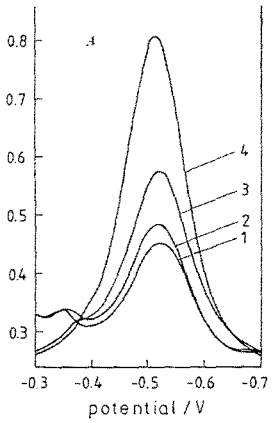


Fig. 1A : A SWCS Voltamograms in seawater (acidifiedto pH = 4 and adjusted to pH = 6,5 at different uranyl(VI) concentrations (1) seawater samples, (2) 4,8 x 10^{-9}, (3) 9,6 x 10^{-9}, (4) 2,56 x 10^{-8} mol l^{-1}

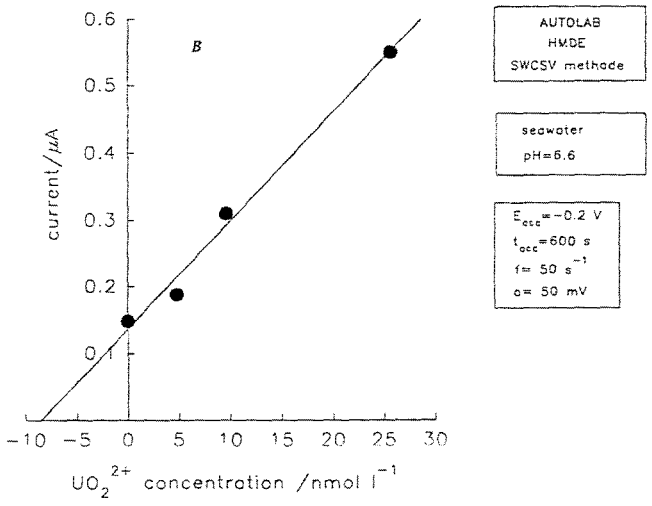


Fig. 1B : Dependence of SWCS peak current on uranyl(VI) concentrations in natural seawater

REFERENCES

T. L. KU, K. G. KNAUSS and G: G. MATHIEU, 1977. *Deep-Sea Res.*, 24 : 1005

R. DJOGIC, L. SIPOS and M. BRANICA, 1986. *Limnol. Oceanogr.*, 31 : 1122

R. DJOGIC and M BRANICA, 1991. *Mar. Chem.* 36 : 121.

R. DJOGIC and M. BRANICA, 1994. *Anal. Chem. Acta* (in press).

CHARACTERIZATION OF ORGANIC MATTER IN THE NORTH ADRIATIC SEA USING O-NITROPHENOL AS A PROBE

B. GASPAROVIC and B. COSOVIC

Center for Marine Research Zagreb, Ruder Boskovic Institute
P.O. Box 1016, 41001 Zagreb, Croatia

Naturally occurring organic matter represents a complex system, not enough investigated so far (80% of all dissolved organic matter species is not characterized), composed of a great variety of compounds which undergo different types of reactions (physical, chemical and/or biological) leading to formation of inorganic or new organic matter. Organic matter is present in the water column in the dissolved, colloidal and particulate state, but its main part is in the dissolved state. North Adriatic sea is a shallow basin rich in organic matter. This region is affected by anthropogenic inputs of organic matter and of nutrients, mainly by the influx of the Po river, leading to algal blooms and excessive production of photosynthetic organisms. This part of the Adriatic sea exhibits pronounced seasonal variations of organic matter as well as horizontal and vertical distribution related to the biological activity (COSOVIC *et al.*, 1985). Usually, the concentrations of dissolved organic matter in the north Adriatic varied within a range of 1-2 mg dm^{-3} (83-166 µM C) (ASCOP, 1992/93).

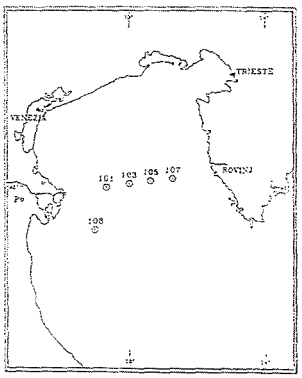


Fig. 1. Map of sampling stations in the north Adriatic sea.

With the aim to find out the method for characterization of organic matter in the natural waters, simple electrochemical method was developed using o-nitrophenol (ONP) as an electrochemical probe. ONP was chosen as a model system according to its appropriate alternating current voltammetry characteristics for studying processes involving organic matter (GASPAROVIC and COSOVIC, 1984). Characterization of the dominant type of organic matter is made by the comparison of the electrochemical characteristics of ONP probe in natural sample with different model systems. It is based on the fact that electrochemical characteristics of ONP (peak potential, half-peak width, peak height and shape) are strongly influenced in the presence of organic matter, which tends to accumulate on the phase boundaries. Model systems contained selected organic substances expected to be found in the natural aquatic environment as naturally occurring organic matter (humic acid, fulvic acid, some fatty acids as representatives of lipid materials, dextranes as representatives of sugars and albumine as a representative of proteines), and organic compounds of anthropogenic origin (tenzides).

Seawater samples are collected monthly at sampling stations presented in Fig. 1 along the transect between croatian and italian coasts. Concentration and composition of the dominant type of organic matter are investigated in seawater samples and in phytoplankton culture media to find out main excretion products during the phytoplankton growth.

Results for the period of 1994 will be discussed. Typical a.c. voltammograms of ONP in absence and in presence of model substances and naturally occurring organic matter in seawater samples are presented in Figs. 2a and 2b., respectively. Comparison is made also to the surfactant activity measurements performed by phase sensitive a.c. voltammetry (COSOVIC *et al.*, 1985) and to DOC values of the samples. The results of this work demonstrate the relevance of the developed model to the real natural waters.

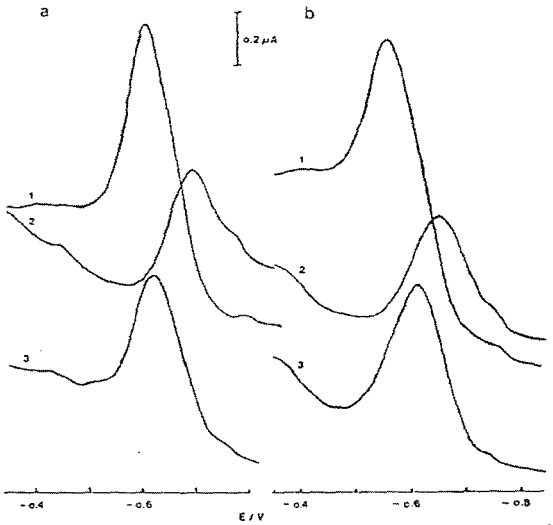


Fig. 2. (a) A.c. voltammograms of 10-4 M ONP in 0.5 M NaCl, pH 8.4; without SAS, acc. time 180 s (curve 1); int he presence of 1 mg/l albumine, acc. time 180 s (curve 2) and 1 mg/l humic acid, acc. time 60 time (curve 3). (b) A.c. voltammograms of 10-4 M ONP in seawater samples, Station 107, 0.5 m, May 17, 1994 (curves 1 and 3), Station 105, 0.5 m, May 17, 1994 (curve 2). Acc. time (1) 0, (2) and (3) 180 s.

REFERENCES

Croatian-Italian Programme of Pollution Monitoring and Protection of Northern Adriatic (ASCOP). Reports for 1992-1993. Zagreb-Rovinj.

COSOVIC, B., ZUTIC, V., VOJVODIC, V. and PLESE, T., 1985. Determination of surfactant activity and anionic detergents in seawater and sea surface microlayer in the Mediterranean, *Mar. Chem.*, 17: 127-139.

GASPAROVIC, B. and COSOVIC, B., 1994, Electrochemical estimation of the dominant type of surface active substances in seawater samples using o-nitrophenol as a probe, *Mar. Chem.*, 46: 179-188.

THIN LAYER CHROMATOGRAPHY AS MODEL SYSTEM FOR INVESTIGATION OF THE MOBILITY OF METALS IN SEDIMENTS. I

O. HADZIJA, S. ISKRIC and S. KVEDER
Ruder Boskovic Institute, P.O.B. 1016, Zagreb, Croatia

The chromatographic studies of the behaviour of some benzene derivatives related to humic acids in connection with Fe(III)-ion were published earlier (HADZIJA *et al.*, 1987; HADZIJA *et al.*, 1988; KVEDER *et al.*, 1992). The natural process of metal mobility in soil and sediments was simulated by using the model system composed of silica gel plates impregnated with aged iron nitrate (representing mineral iron hydroxy/oxide support) on which the model compounds representing the types of structures that probably occur in humic acids were chromatographed with water as developer.

By this simple experimental system we could follow the conduct of the compounds with various functional groups and deduce of their abilities to detach the Fe(III)-ion from the support to the solution. We also examined the behaviour of commercial humic acids under the same conditions and compared their behaviour with those of the model compounds (ISKRIC *et al.*, 1994). The results are given in the Table 1 where R_f values represent parameters of the solubility and mobility of the complexes formed by detaching of Fe(III)-ion from the support. Comparing the Rf's of the model compounds with those of humic acids one can see that humic acids moved considerably, as well as catechol and salicylic acid. Thus it can be concluded that humic acids tested have similar functional groups in their structures which can detach Fe(III)-ion from the support.

Table 1 : R_f x 100 values of hydroxy and carboxy benzene derivatives and humic acids on Fe(III)-impregnated silica gel plates. Developer: tap water

No	Compound	Structures	R_fx100	Ref
I	Catechol		78	3
II	Pyrogallol		0-71	3
III	Benzoic acid		16	3
IV	o-Phthalic acid		23	3
V	Salicylic acid		90	1
VI	Gallic acid		0-37	3
VII	3,4,5-Trimethoxy benzoic acid		6	1
IX	Humic acid "EGA"		0-88	4
X	Humic acid "Fluka"		0-88	4
XI	Humic acid "GMS"		0-60	4

REFERENCES

O. HADZIJA, S. ISKRIC and M. TONKOVIC, 1987. *J. Chromatogr.* 402 :358-360
O. HADZIJA, S. ISKRIC and M. TONKOVIC, 1988. *J. Chromatogr.* 460 : 220-222
S. ISKRIC O. HADZIJA and S. KVEDER, J. LIQ. 1994. *Chromatogr.* 17 : 1653
S. KVEDER, S. ISKRIC N. ZAMBELI and O. HADZIJA, J. LIQ. 1992. *Chromatogr.* 15 : 1719-1727

THIN LAYER CHROMATOGRAPHY AS MODEL SYSTEM FOR INVESTIGATION OF THE MOBILITY OF METALS IN SEDIMENTS. II

S. ISKRIC, B. SPOLJAR and O. HADZIJA
Ruder Boskovic Institute, P.O. B. 1016, Zagreb, Croatia

In soil and sediments, organic and inorganic components are closely connected by forming salts and complexes and the consequence of these interactions is moving or sedimentation of metals. In the present work we examined, by the use of model experimental system, the behaviour of some toxic heavy metals (Pb(II), Cu(II), Cd(II), Zn(II)) in interaction with compounds, simulating the probable structure of humic acids.

The model system was chromatography of benzene derivatives of typical structures on thin layer of silica gel impregnated with metal salts and with tap water as the mobile phase. On the basis of the behaviour, i.e. R_f values, some conclusions about the solubility and consequently mobility of the complexes formed could be drawn.

All the model compounds except resorcinol show at the start position one spot, what may indicate their partial retardation effect. Resorcinol moved considerably indicating that the hydroxy groups improved the mobility of the metals. Other compounds tested beside the spot on the start position exhibit another spot having higher mobility. This was observed with benzoic and syringic acids on Pb(II), Cd(II) and Zn(II) impregnation and with o-phthalic acid and salicylic acid on Cu(II), Cd(II) and Zn(II) impregnation. One can conclude that with exception of resorcinol the model compounds formed with the support two kinds of complexes - one improving the mobility and the other retarding the metals.

Table 1. R_f x 100 values of hydroxy and carboxy benzene derivatives on Cu(II)-, Pb(II)-, Cd(II)- and Zn(II)-impregnated silica gel plates. Developer: tap water

		R_fx100							
Compound	Structure	Impregnant: Cu(II)		Pb(II)		Cd(II)		Zn(II)	
		R_{f_1}	R_{f_2}	R_{f_1}	R_{f_2}	R_{f_1}	R_{f_2}	R_{f_1}	R_{f_2}
Benzoic acid		11	-	7	70	0	67	0	77
o-Phthalic acid		7	50	18	-	10	55	9	58
Syringic acid		0	-	13	74	0	68	5	86
Salicylic acid		7	32	6	64	6	65	7	62
Resorcinol		-	49	-	69	-	77	-	74

C

ADSORPTION OF LEAD AND CADMIUM IONS ON CALCITE IN SEAWATER IN THE PRESENCE OF NONIONIC AND CATIONIC TENZIDES

S. KOZAR[1], H. BILINSKI[2], N. FILIPOVIC-VINCEKOVIC[2] and M. BRANICA[1]

[1] Center for Marine Research, [2]Department of Physical Chemistry, Ruder Boskovic Institute, P.O.B 1016, 41001 Zagreb, Croatia

Immobilisation of dissolved trace metals by natural particulate matter and sediments in aqueous environment, together with possible remobilization influenced by different factors are determining the quality of an aquifier.

This work is a continuation of our adsorption studies on trace metal ions on calcite and benthonite (BILINSKI *et al.*, 1991; KOZAR *et al.*, 1992). In the present work the adsorption of lead and cadmium ions were studied on calcite added to seawater in the presence of model surface active substances (SAS), such as dodecyl pyridinium chloride (DPCl) and triton X-100 used respectively as positively and zero charged surfactants. Critical micellar concentrations (cmc) were determined in seawater medium from surface tension measurements.

Adsorption isotherms of the two tenzides were determined on calcite in seawater medium and in 0.55 mol NaCl l^{-1} to get the surface coverage values. Adsorption of lead and cadmium ions was studied on coverage calcite surfaces.

Total concentrations of lead and cadmium ions were $2x10^{-7}$ mol l^{-1}. After adsorption solid phase was removed by filtration and lead and cadmium concentrations were measured by differential pulse anodic stripping voltammetry (DPASV).

The effects of the mentioned tenzides on imobilization or remobilization of cadmium and lead from calcite particles into water phase, are discussed.

C

REFERENCES

BILINSKI, H., KOZAR, S., PLAVSIC, M., KWOKAL, Z., and BRANICA, M., 1991. Trace metal adsorption on inorganic solid phases under estuarine conditions. *Mar. Chem.*, 32 : 225-233.

BILINSKI, H., SIRAC, S., KOZAR, S., BRANICA, M., and SCHWUGER, M.J., submitted for publication in *Water Res.*

KOZAR, S., BILINSKI, H., *AND* BRANICA, M., 1992. Adsorption of lead and cadmium ions on calcite in the Krka estuary. *Mar. Chem.*, 40 : 215-230.

KOZAR, S., BILINSKI, H., BRANICA, M., and SCHWUGER, M.J., 1992. Adsorption of Cd(II) and Pb(II) on bentonite under estuarine and seawater conditions. *Sci.Tot.Environ.*, 121 : 203-216.

INFLUENCE OF HYDROPHILIC AND HYDROPHOBIC SUBSTANCES ON PHYSICO-CHEMICAL PROPERTIES OF SURFACE FILMS

Z. KOZARAC[1], B. COSOVIC[1], V. VOJVODIC[1], D. MÖBIUS[2]

1 Center for Marine Research Zagreb, Ruder Boskovic Institute, Zagreb, Croatia
2 Max Planck Institut für Biophysikalische Chemie, Gottingen, Germany

Natural aquatic systems contain a large number of organic substances with different functional groups and different hydrophobic and hydrophilic properties. Surface active organic compounds which are released by phytoplankton as a product of its metabolism or are originating from decomposition and degradation processes of dead organisms form the surface microlayer (50-100 μm) which represents the interfacial region where many important bio-physico-chemical processes and flux of gases are taking place. Natural films are composed of free fatty acids, alcohols and hydrocarbons as well as of more oxygenated molecules of higher molecular weights such as glycopeptido-lipid-oligosaccharide complexes (DARRIGO, 1984). Although carboxydrates are water soluble compounds, they can form highly insoluble monolayer due to hydrogen binding and nonpolar interactions with lipid insoluble components. In the case of charged polyelectrolytes the interaction with functional groups of lipid films can be expected too. In adsorption at interfaces both hydrophobic and electrostatic (ionic) interactions determine the surface excess of solute species at natural boundaries. However, the hydrophobic fraction of surface active material was found more enriched in the surface microlayer collected at the natural air/seawater interface than were the total surfactants and total DOC (COSOVIC and VOJVODIC, 1989). Investigations of equilibrium and kinetic parameters of relevant interfacial processes can be carried out on real interfaces but very often it is more practical and convenient to use model interfaces. Two model interfaces, namely the air/water and the mercury electrode/solution interface are mostly used. Both interfaces are hydrophobic in nature and show similar adsorption effects for many organic substances (DAMASKIN *et al.*, 1971). The main advantage of the mercury electrode is its uniform, reproducible, renewable surface, smooth and energetically controlled, while monolayer techniques that are used for studies at air/water interface provide methods to organize appropriate molecules in a planned way and to study interactions at the interface under controlled conditions. There is also a possibility of transfering the film from the air/water interface to the mercury surface (PAGANO and MILLER, 1973, NELSON and BENTON, 1986, KOZARAC *et al.*, 1991). Lipid coated electrodes have interesting practical applications. Interactions of the lipid with various species in the bulk solution can be monitored electrochemically and ion and charge transfer across the film, as well as the interactions in the film can be detected. Lipid coated electrode represents also a very sophisticated system for the study of the structure and functioning of biological membranes.

Substances like long chain fatty acids and alcohols, polyoxyethylene and polysaccharides can be used as model for naturally occuring constituents which influence the physico-chemical processes at the air/water interface. Polysaccharide xantan is water soluble biopolymer ($M_w=2x10^6$) of microbial origin having polyelectrolyte properties. It has a five sugar repeat unit, two types of carboxyl groups and a celulose backbone (RINAUDO and MILAS, 1982). It was used in this work as a model for hydrophilic big molecule which can interact with different more hydrophobic substances by ionic and hydrophobic bonds.

Here we present results of the adsorption studies of xantane at the mercury electrode surface and at the air/water interface, as well as its interaction with different lipid film forming material like oleic acid, phosphatidyl cholines, phosphatidic acid and others. Adsorption studies at the mercury electrode were performed by capacity current measurements using phase sensitive a.c. voltammetry. The structure and permeability of lipid layers were tested by using redox processes of cadmium as a probe for transport through the layer.

Studies at the air/water interface have been done by surface pressure and surface potential measurements. It was found that xantan being predominantly hydrophilic belongs to less adsorbable substances at the mercury electrode and is only slightly adsorbed at the air/water interface. It was also found that xantan interacts with both positively charged and uncharged lipid monolayers what can be clearly seen from surface pressure-area and surface potential-area isotherms. Lipid monolayers when, spread on xantan solution show the expansion of monolayer area and disappearance of the phase transition. Such a phenomenon indicates interaction of the solute xantan with the monolayer and may be interpreted as partially incorporation of polyelectrolyte molecule into the matrix monolayer.

Adsorbed layer of xantan at the mercury surface was found to be transparent for the transport of cadmium ions through it at the pH values of natural waters (pH=7-8). At lower pH (pH=2) the structure of polyelectrolyte changes and more compact layer of xantan was obtained.

Adsorbed layer of oleic acid inhibits the transport and redox processes of cadmium at the mercury electrode in both neutral and acidic media. The mixed adsorbed layer is formed if both substances, xantan and oleic acid are present in solution showing complex influence on transport processes.

REFERENCES

D'ARRIGO J.S., 1984. Surface properties of microbubble-surfactant monolayers at the air/water interface. *J. Colloid Interface Sci.*, 100: 106-111.

COSOVIC B. and VOJVODIC V., 1989. Adsorption behaviour of the hydrophobic fraction of organic matter in natural waters. *Mar. Chem.*, 28 :183-198.

DAMASKIN B.B., PETRII O.A. and BATRAKOV V.V., 1971. Adsorption of Organic Compounds on Electrodes, Plenum Press, New York, 37.

PAGANO R.E. and MILLER I.R., 1973. Transport of ions across lipid monolayers. *J. Colloid Interface Sci.*, 45: 126-137.

NELSON A. and BENTON A., 1986. Phospholipid monolayers at the mercury/water interface. *J. Electroanal. Chem.*, 202: 253-270.

KOZARAC Z., KLARIC R., DRAGCEVIC D and COSOVIC B., 1991. Electrochemical and monolayer studies of the lipid layers at hydrophobic interfaces: air/water interface and mercury surface. *Colloids and Surfaces*, 56: 279-291.

RINAUDO M. and MILAS M., 1982. Xantan properties in aqueous solution. *Carbohydrate Polymers*, 2: 264-269.

TEMPORAL CHANGES IN CHEMICAL PROPERTIES OF A WARM CORE EDDY IN THE LEVANTINE BASIN OF THE EASTERN MEDITERRANEAN SEA

Nurit KRESS[1], Michael D. KROM[2] and Louis I. GORDON[3]

[1] Nal Inst. of Oceanography, Israel Oceanographic and Limnological Res, Haifa , Israel
[2] Dept. of Earth Sciences, University of Leeds, Leeds LS2 9JT, United Kingdom
[3] Col. of Oceanography and Atmospheric Sc., Oregon State Univ., Corvalis, Oregon, USA

Recently a persistent quasi-stationary warm-core eddy has been found south of Cyprus in the Levantine basin of the eastern Mediterranean Sea. A series of nine cruises over a three-year period (1989-1992) was carried out to examine its physical and chemical structure (BRENNER *et al.*, 1990; KROM *et al.*, 1992, 1993). The eddy is characterized by an isothermal, isohaline lens of water wedged between the seasonal and permanent thermoclines. In the winter, this thermostad extends from the surface to a depth of nearly 400 m, while in other seasons it lies in the layer from 200-400 m. Similarly, dissolved oxygen and nutrient (nitrate, o-phosphate and silicic acid) concentrations at the eddy core are essentially constant during winter, from the surface to a depth of 550 m, while during summer, the concentrations are constant at the depth interval 150-550 m.

Temporal changes in temperature and salinity values at the eddy core indicated a process of renewal or replacement of the water trapped in the core of the eddy (BRENNER, 1993) and therefore we assumed that between February 1989 and March 1992 three different realizations of the Cyprus eddy were sampled. We examined the chemical characteristics of the core water during this time in order to check if the chemical parameters could be indicative of changes related to the proposed renewal processes. Each time when temperature and salinity increased, an increase in dissolved oxygen concentration followed, consistent with the fact that "new" water formed or flushed the eddy core (Table 1). During the period that the core was isolated from the surroundings, oxygen was utilized and the concentration decreased, increasing after the water renewal. It is therefore possible to see a cycle during the lifetime of a particular eddy. The increase in oxygen concentration indicates penetration of surface (or upper layer), oxygen rich water and not lateral penetration of water at the same depth as the core. Only during November 1989 we detected a deviation from this trend and saw a slight increase in dissolved oxygen.

The changes in nitrate concentration were consistent with those noticed for the dissolved oxygen, but not as "unequivocal". The beginning of the eddy cycle was characterized by a decrease in nitrate concentration, followed by an increase during the time that the core was isolated from the surrounding water. An exception is the nitrate concentration found during September 1989, lower than the values found in May and November 1989.

Assuming that: a) the core water is isolated from the surroundings during the lifetime of the eddy; b) all the addition of nitrate to the core during the eddy's lifetime is due to decomposition of organic matter and c) surface water with negligible amounts of nitrate intrudes the core to form a new eddy, it is possible to compare the changes in dissolved oxygen and nitrate concentrations in the core of the eddy. The difference between the average dissolved oxygen concentration found in the core of Eddy-08 and Eddy-09, was 8.1 µmole/kg (Table 1). Using Redfield's ratio of 138:16 for O_2:NO_3, the respective calculated amount of nitrate depletion is 0.94 µmole/kg. The decrease in nitrate concentration actually measured was 0.86 µmole/kg, a very good fit. The same comparison was performed for Eddy-06 and Eddy-07. The difference in dissolved oxygen concentration measured was 4.8 µmole/kg, corresponding to a calculated value of 0.55 µmole/kg nitrate. The measured decrease in nitrate concentration was 0.47 µmole/kg, again in very good agreement with the calculated value.

Ortho-phophate concentrations were expected to follow nitrate concentration. As a whole it is true except for an unexplained increase during April 1990. However, one must keep in mind that the ortho-phosphate concentrations measured in the core of the eddy are very close to the detection limit of the method (KROM *et al.* 1992, 1993).

Date	Cruise no.	Temp. °C	Sal ppt	O_2	NO_3	PO_4	$Si(OH)_4$
				µmol/kg			
5/88	02	16.44	39.08	222.8 (2.3)	0.55 (0.18)	0.008 (0.009)	1.55 (0.24)
2/89	03	16.43	39.15	220.0 (1.6)	0.57 (0.07)	<0.01	0.99 (0.06)
5/89	04	16.43	39.15	216.0 (0.9)	0.73 (0.10)	0.013 (0.004)	0.92 (0.06)
9/89	05	16.43	39.15	------	0.47 (0.34)	0.014 (0.009)	0.89 (0.27)
11/89	06	16.43	39.15	219.0 (1.6)	1.23 (0.35)	0.034 (0.015)	1.11 (0.36)
*4/90	07	16.68	39.27	223.8 (0.6)	0.76 (0.22)	0.051 (0.021)	1.36 (0.48)
10/90	08	16.68	39.27	214.3 (1.8)	1.02 (0.41)	0.021 (0.029)	1.29 (0.34)
*3/92	09	16.61	39.38	222.4 (1.2)	0.16 (0.05)	0.006 (0.006)	1.58 (0.06)

Table 1: Physical and Chemical characteristics of the eddy core (in parenthesis, standard deviation, * renewal of the eddy)

REFERENCES

BRENNER S. 1993. Long term evolution and dynamics of a persistent warm core eddy in the Eastern Mediterranean Sea. *Deep-Sea Research*, 40: 1193-1206.

BRENNER S., ROZENTRAUB Z., BISHOP J. and KROM M.D. 1990. The Mixed Layer/Thermocline Cycle of a Persistent Warm Core Eddy in the eastern Mediterranean. *Dynamics of Atmospheres and Oceans*, 15: 457-477.

KROM M. D., BRENNER S., KRESS N., NEORI A. and GORDON L.I. 1992. Nutrient dynamics and new production in a warm-core eddy from the Eastern Mediterranean Sea. *Deep-Sea Research*, 39: 467-480.

KROM M. D., BRENNER S., KRESS N., NEORI A. and GORDON L.I. 1993. Nutrient distributions during and annual cycle across a warm-core eddy from the E. Mediterranean sea. *Deep-Sea Research*, 40: 805-825.

SOIL DERIVED DUST PARTICULATES OVER THE EASTERN MEDITERRANEAN

KUBILAY N.[1], SAYDAM C.[1], NICKOVIC S.[2] and DOBRICIC S.[2]

[1] Middle East Technical University-Institute of Marine Sciences, P.O. Box 28, 33731 Erdemli-Icel, Turkey
[2] ICSC-World Laboratory, Project LAND-3, Via Guarnotta 26, Erice, Italy

Beginning from 1991 a continuous aerosol sampling program is being carried out at a coastal location of the eastern Mediterranean (34°15'18"E, 36°33'54"N). Totally, 339 aerosol samples were collected by utilizing a hi-vol pump during August 1991-December 1992 on daily basis. Soil derived dust load (mineral particulates) concentrations in the atmosphere were estimated from the measured Al concentrations which is 8% of the average crustal material. The arithmetic average value of 1255 ng Al m^{-3} of air for the eastern Mediterranean aerosol yields an average dust loading of 15.5±25 µg m^{-3} of air over the region. The geometric mean of the dust concentration for the study period is 8.4 μm^{-3}. The wide concentration range (0.25-287 µg m^{-3}) during the sampling period is the explanation of the high standard deviation of the average concentration. Temporal variation of the dust load concentration is highly variable on a time scale of one day (Fig.1). The daily precipitation amounts obtained from the nearest meteorological office are also plotted on the same figure. Our data indicate a seasonal pattern for the dust concentrations over the eastern Mediterranean atmosphere: during wet period (December-February), the arithmetic mean concentration is 4.5 µg m^{-3} whereas for the dry summer time (June-September) it is 15.7 µg m^{-3}. As can be seen from the figure sporadic dust load concentration peaks were observed in spring and fall time. This time periods have well defined meteorological processes on synoptic scale which result in long-range transport (LRT) of soil derived dust from the surrounding deserts (DAYAN, 1986; DAYAN *et al.*, 1991). Our data suggest that precipitation and LRT of soil derived dust are the major factors causing the intense time variation. Indeed, it appears from the figure that precipitation events are systematically followed by abrupt decreases of the dust concentration. For example during October 1991 an event which has the maximum dust loading throughout the sampling period was sampled (279 µg m^{-3}). After this enormously high dust loading a local rain event caused two orders of magnitude decrease in the dust concentration (5.3 µg m^{-3}). October 1991 event is one of the episodes observed associated with LRT of dust from the desertic areas. Air parcel back-trajectory calculations are evaluated as a basic tool to detect potential remote source areas for the dust particles over the sea. The trajectory model of European Center for Medium-Range Forecasts (ECMWF) is applied to three dimensional analyzed wind fields available at the archive of the center. Calculations are performed as three days backward, starting at the mid time of the day (12 00 UT) and arriving to the receptor coordinates at 900, 850, 700, 500 hPa standard pressure levels. Examples of the trajectories originated from Saharan desert (Fig.2.a) and Arabian Peninsula (Fig.2.b) are given in Fig.2. Total (wet+dry) annual flux of the dust deposition is estimated and extrapolated to the eastern Mediterranean (320 000 km^2). The conclusion of this study served as a basis for the simulation of desert dust transport to the Mediterranean by utilizing NMC/Eta model.

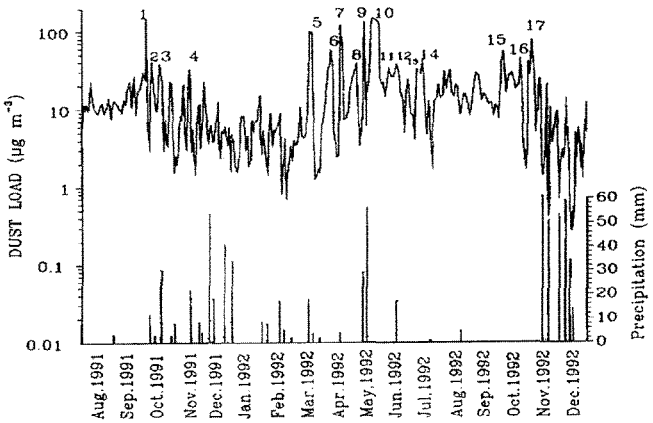
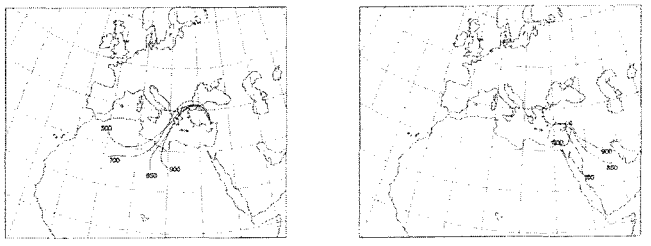


Figure 1. Temporal variation of the dust loading and local precipitation events.



(a) (b)

Figure 2. Air mass back-trajectories for the situations on (a) 6 Oct. 1992, (b) 5 Nov.1992.

REFERENCES

DAYAN U., 1986. Climatology of back trajectories from Israel based on synoptic analysis. *J. Climate Appl. Meteorol.*, 25, 5, 591-595.

DAYAN U., HEFFTER J., MILLER J. and GUTMAN G. (1991). Dust intrusion events into the Mediterranean basin. *J. Appl.Meteo.*, 30, 8, 1185-1199.

BASIC HYDROGRAPHIC AND CHEMICAL DATA FROM TWO MICROLOCATIONS AT THE EASTERN ADRIATIC COAST LINE : THE ROGOZNICA LAKE AND THE ROGOZNICA UNDERWATER CAVE

Grozdan KUSPILIC and Ante BARIC

Institute of Oceanography and Fisheries, 58000 Split, P.O.Box 500, Croatia

Based on time–to–time occurrences of brown–reddish colored surface water, the Rogoznica Lake (Fig. 1) is a locally mystified lake, named "The Dragons eye". The lake covers a surface of about 5000 m^2, with an average depth of 10 m. Salinity data (Fig. 2) indicate the existence of a Lake–Sea connection. The vertical temperature profile (Fig. 2) shows a remarkable "high temperature" layer in spring. Investigations of the basic chemical properties have shown a vertical decrease of oxygen and the occurrence of H_2S in the bottom layer. In the anoxic layer nitrate was converted to ammonia. Phosphate and silicate are found to be strongly enriched. Hydrographic and chemical data for the lake refer to 11 a.m. on March 31, 1993.

The Rogoznica underwater cave, named "The Dragons ear", (Fig. 1) has an opening of d=1.5 m two meters below the sea level. The cave extends to a depth of 28 meters, with an average width of 10 m. In comparison to a nearby reference station, the vertical temperature distribution in the cave showed a higher degree of stratification (Fig. 3). Oxygen saturation in the cave decreases rapidly below the thermocline down to 40% at the bottom layer (Fig. 4). A similar trend was also established for pH. Contrary to oxygen and pH, the vertical distribution of nutrients (Figs. 5, 6) showed much stronger gradients at the reference station then in the cave. Data shown in Figs. 3, 4, 5 refer 11 a.m. (cave) and 1 p.m. (ref. station) on August 18, 1993.

Hydrographic data from these two locations were collected using a TS sonde (Rosemount RS–5), dissolved oxygen was determined by Winckler titration, while nutrients were analyzed on a Technicon AutoAnalyzer II.

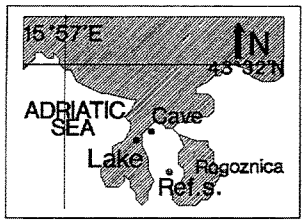


Fig. 1. The Rogoznica area

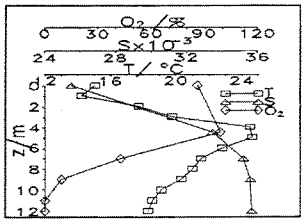


Fig. 2. Vertical distribution of temperature, salinity and oxygen in the lake

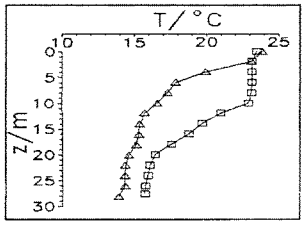


Fig. 3. Temperature distribution in the cave (□-□) and at ref. station (Δ-Δ)

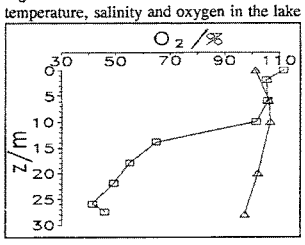


Fig. 4. Oxygen distribution in the cave (□-□) and at ref. station (Δ-Δ)

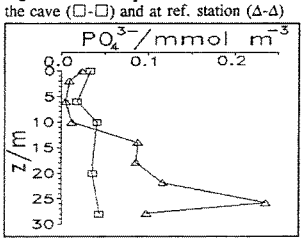


Fig. 5. Phosphate distribution in the cave (□-□) and at ref. station (Δ-Δ)

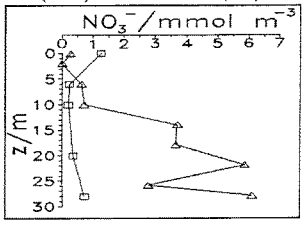


Fig. 6. Nitrate distribution in the cave (□-□) and at ref. station (Δ-Δ)

INTERACTION OF LANTHANUM WITH CADMIUM INFLUX ACROSS ISOLATED *CARCINUS* GILL

Cedomil LUCU[1] and Vojko OBERSNEL[2]

[1]Center for Marine Research Rovinj, Ruder Boskovic Institute, 52210 Rovinj, Croatia
[2] Faculty of Medicine, University of Rijeka, 51000 Rijeka, Croatia

The effect of the non specific Ca channel blocker La on the ^{109}Cd influxes in isolated perfused *Carcinus* gills were studied. The influx of ^{109}Cd are shown to be lanthanum concentration dependent processes. The half-maximum inhibition of cadmium influxes by La was at 1.4 x 10^{-6} mol l^{-1}. Cadmium transport is discussed in terms of non-specific influx utilizing Ca channels. The gills are the most important interface barriers of the cadmium transport between the marine organisms and their environment. In spite of the large number of reported evidences on cadmium bioaccumulation and toxicity, there has been poorly studied transport mechanisms of cadmium through the cells and tissues of aquatic organisms. In isolated membrane vesicles lanthanum was shown to be a powerful blocker of a Na^+/Ca^{+2} exchanger (KACZOROWSKI *et al.*,1984) and membrane Ca^{+2} ATPase activity (WUYTACK and RAEYMAEKERS, 1992). In freshwater trout gills basolaterally located Ca dependent ATPase and Na^+/Ca^{+2} exchanger with extremely high Cd affinity was found experimentally (SCHOENMAKERS *et al.*,1992). Studies of the effects of lanthanum on Cd influxes have been undertaken as a means of further characterization of Cd transport mechanisms. Adult male crabs, *Carcinus mediterraneus* Csrn. (5.5 ± 0.5 cm carapace width), were collected from estuaries of the Venice lagoon. They were acclimated to controled laboratory conditions for at least 2 weeks to aerated sea water diluted by distilled water (DSW;18 x 10^{-3} salinity) at room temperature (t = 20 ± 2°; pH = 7.8 ± 0.1). The animals were fed once a week on slices of bovine heart.The posterior 7th and 8th gill pairs, which are rich in mitochondria-containing chloride cells and which have high Na, K ATPase activity were excised from the adult crabs and perfused, according to the technique described by LUCU and SIEBERS (1986). The effect of lanthanum ($LaCl_3$) on ^{109}Cd influxes is presented on Fig.1. Lanthanum was added to the DSW in concentrations ranging from 10^{-7} to 10^{-6} mol l^{-1}. Lanthanum clearly inhibited ^{109}Cd influxes. Half-maximum inhibition (IC50) of cadmium influx in the gills after 2 h exposure in $LaCl_3$ were 1.4 x 10^{-6} mol l^{-1}. In addition, ^{109}Cd influx is strongly inhibited by $LaCl_3$ acting particularly from the external medium at the apical gill epithelium surfaces. Moreover, apically applied 9 x 10^{-6} mol La l^{-1} in the bathing solution has been found to reduce Ca influxes (IC_{50}) for 50 % of the control group (LUCU, 1994). In the perfused *Carcinus* gills, when Ca was added apically Cd influx inhibition was more pronounced than in the experiment when Ca was added basolaterally.

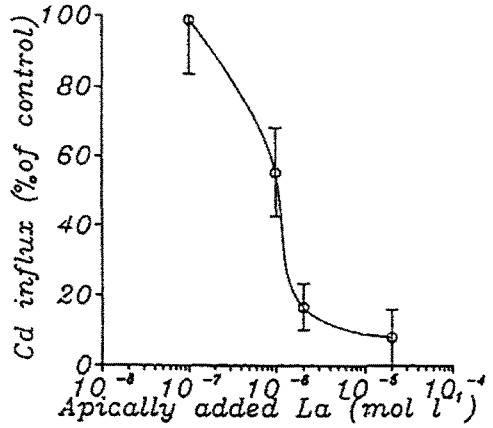


Fig. 1 Response of $LaCl_3$ (10^{-7} to 10^{-5} mol l^{-1}) on ^{109}Cd influxes determined at the steady state level. Values are a mean of 5 determinations ±SEM. Total cadmiumconcentration in medium was 0,26 µmol Cd l^{-1}. Dilute sea water (DSW) wasenriched by Ca (15 mmol ^{Ca} l^{-1}).

This suggests that Cd enter the gill epithelium via a lanthanum-sensitive apical Ca channel. We have used La as an non specific blocker acting selectively from apical perfused *Carcinus* gill surfaces.The entry of cadmium over the apical membrane of gill epithelium cells via Ca^{2+} channels has already been described for the freshwater-adapted trout (PERRY and FLIK, 1988).Vital mechanism of the postmoult Crustacea is the ability to increase Ca absorption for the purpose of rapid calcification of their exoskeleton.It will be stimulating, in the future, to continue studies on the interaction mechanisms of calcium with highly toxic metal cadmium, which effects could be especially hazardeous during such a sensitiver living phase of Crustacea as it is moulting.

REFERENCES

KACZOROWSKI G.J., COSTELLO L., DETHMERS J., TRUMBLE, M.J. and R.L. VANDLEN, 1984. Mechanisms of Ca^{+2} transport in plasma membrane vesicles prepared from cultured pituitary cells. *J. Biol. Chem.* 259, 9395-9403.

LUCU C. and D. SIEBERS, 1986. Amiloride-sensitive sodium flux and potentials in perfused *Carcinus* gill preparfations. *J. exp. Biol.* 122,25-35.

LUCU C., 1994. Calcium transport across isolated gill epithelium of Carcinus. *J. Exp. Zool.* 268, 339-346.

PERRY S.F. and G. FLIK, 1988. A characterization of branchial transepithelial calcium fluxes in the freshwater trout (Salmo gairdneri). *Am. J. Physiol.* 254, R491-R498.

SCHOENMAKERS T.J.M., P.H.H. KLAREN, F. FLIK, R.A.C. LOCK, P.K.T. PANG and S.E. WENDELAAR BONGA, 1992. Actions of cadmium on basolateral plasma membrane proteins involved in calcium uptake by fish intestine. *J. Membrane Biol.* 127. 161-172.

WUYTACK F. and L. RAYMAEKERS, 1992. The Ca^{+2}-transport ATPases from the plasma membranes. J. Bioenerg. *Biomembranes*, 24, 285-300.

RÉÉVALUATION DES FLUX ATMOSPHÉRIQUES DE MÉTAUX-TRACES EN MER LIGURE

Christophe MIGON, Emmanuel NICOLAS and Blandine JOURNEL

Laboratoire de Physique et Chimie Marines, Université de Paris 6, INSU CNRS, La Darse, BP 8, F-06230, Villefranche-sur-Mer, France

L'étude des flux atmosphériques des métaux-traces est un facteur essentiel pour la compréhension des cycles biogéochimiques de ces éléments. Cependant, l'estimation de ces flux est très difficile, non seulement en raison de la variabilité saisonnière et interannuelle des apports, mais aussi à cause des problèmes liés à la mesure du dépôt atmosphérique. En effet, si l'estimation du dépôt humide est relativement aisée, les vitesses de chute de l'aérosol sec sont très difficiles à évaluer et il existe une grande incertitude dans les valeurs de flux ou de bilans atmosphériques proposées actuellement.

Le site d'échantillonnage est le Cap Ferrat (43°41'10"N, 7°19'30"E). Cette station côtière est supposée représentative de la mer Ligure (MIGON *et al.*, 1991). Trois types d'apports atmosphériques sont pris en compte sur une base de temps hebdomadaire : les retombées humides, sèches et totales.

i) Les pluies sont collectées à l'aide d'un pluviomètre automatique (KFA-Jülich) équipé d'un détecteur d'humidité qui commande l'ouverture du dispositif lors de chaque événement pluvieux.

ii) Les aérosols sont prélevés par pompage de l'air ambiant à travers un filtre de porosité 0,45 µm. Le débit moyen de la pompe étant de 10 litres par minute, environ 100 m^3 d'air sont filtrés après une semaine de pompage.

iii) Les retombées totales : ce paramètre est censé représenter la quantité de matière (ou d'éléments qui composent cette matière) qui se dépose à la surface de la mer. Il est évalué de la manière suivante : un volume connu d'eau de mer acidifiée dont la composition en traces métalliques a été préalablement déterminée est placé dans un récipient de section connue, maintenu ouvert. Après une semaine d'exposition sur le site et avec compensation de l'évaporation, cette solution est filtrée, puis les éléments sont dosés. La quantité d'éléments déposée dans le récipient est calculée par différence des mesures des concentrations après et avant exposition. Cette quantité représente la somme des retombées totales (humides + sèches) pour la durée considérée, ici une semaine.

Les éléments analysés sont Pb, Cd, Cu, Ni et Co. Les prélèvements se sont étalés d'octobre 1992 à septembre 1993.

La difficulté d'estimation du dépôt sec a déjà été discutée (ARIMOTO et DUCE, 1986; BERGAMETTI, 1987; MIGON *et al.*, 1991). Par exemple, on trouve dans le cas du plomb une grande marge d'erreur entre la vitesse de chute théorique (0,041 $cm.s^{-1}$; DULAC *et al.*, 1989), calculée à partir de modèles et la vitesse expérimentale obtenue à partir de données d'impacteur (1,9 $cm.s^{-1}$; REMOUDAKI, 1990). Une telle incertitude conduit naturellement à des estimations de flux très douteuses. La méthodologie proposée ici permet de contourner ce problème. On obtient ainsi des valeurs de flux totaux qui sont reportées au tableau ci-dessous, de même que les bilans annuels pour la mer Ligure :

	Flux total moyen ($kg.km^{-2}.an^{-1}$)	Apport annuel moyen à la mer Ligure ($tonnes.an^{-1}$)
Pb	3,14	166
Cd	0,065	3,5
Cu	2,08	110
Ni	1,30	69
Co	0,13	6,8

Ces valeurs sont à comparer aux résultats précédemment publiés (MIGON *et al.*, 1991). Pour Pb, par exemple, en tenant compte des apports secs calculés (valeur minimale) et mesurés expérimentalement (valeurs maximale), on avait l'intervalle 3,3 - 18 $kg.km^{-2}.an^{-1}$. On constate que les flux et les bilans proposés ici sont compris entre ces valeurs extrêmes. De même, pour tous les éléments considérés, les valeurs présentées sont tout à fait compatibles avec ces anciens résultats, comme avec ceux proposés par GUERZONI *et al.* (1988) pour la Méditerranée occidentale.

RÉFÉRENCES

ARIMOTO, R. et DUCE, R.A. (1986). Dry deposition models and the air-sea exchange of trace elements. *J. Geophys. Res.*, 88, 2787-2792.

BERGAMETTI, G. (1987). Apports de matière par voie atmosphérique à la Méditerranée occidentale : aspects géochimiques et météorologiques. Thèse d'Etat, Université Paris 7, 296 pp.

DULAC, F., BUAT-MÉNARD, P., EZAT, U., MELKI, S. et BERGAMETTI, G. (1989). Atmospheric input of trace metals to the Western Mediterranean : uncertainties in modelling dry deposition from cascade impactor data. *Tellus*, 41B, 362-378.

GUERZONI, S., LENAZ, R. et QUARANTOTTO, G. (1988). Fields measurements at sea : atmospheric trace metals "end-members" in the Mediterranean. *In* : S. BEILKE, J. MORELLI et G. ANGELETTI (Eds), Fields Measurements and their Interpretation. Air Pollution Report 14, 96-100.

MIGON, C., MORELLI, J., NICOLAS, E. et COPIN-MONTÉGUT, G. (1991). Evaluation of total atmospheric deposition of Pb, Cd, Cu and Zn to the Ligurian Sea. *Sci. Total Environ.*, 105, 135-148.

REMOUDAKI, E. (1990). Etude des processus contrôlant la variabilité temporelle des flux atmosphériques de polluants et de poussières minérales en Méditerranée occidentale. Thèse d'Université, Université Paris 7, 223 pp.

DISTRIBUTION OF ORGANIC AND TOTAL LEAD BETWEEN MUSSELS *MYTILUS GALLOPROVINCIALIS* AND SEAWATER

N. MIKAC[1], M. BRANICA[1], Y. WANG[2] and R.M. HARRISON[2]

[1]Center for Marine Research Zagreb, Institute Ruder Boskovic, Zagreb, Croatia
[2]School of Biological Sciences, University of Birmingham, United-Kingdom

Organolead compounds are introduced into the environment by their use as anticnock additive in gasoline. It was estimated that about 1% of the lead in gasoline is emitted from vehicles in the form of tetra- and trialkyllead compounds. The presence of alkyllead compounds was established in different kinds of abiotic environmental samples (air, rainwater, surface waters, sediment, dust), but, there is a lack of data on level and behaviour of these compounds in biota. Particularly, there is no data on the level of organolead compounds in mussels *(Mytilus* species), which are well known as indicator organism of heavy metal pollution. The aim of this work is to establish the level of organolead compounds in mussels Mytilus galloprovincialis from the Eastern Adriatic Coast and to study a bioaccumulation of these compounds to mussels in their natural habitats.

For the organolead determination homogenized mussels tissue is digested in TMAH (tetramethylammonium hydroxide), organic lead is extracted into hexane in the form of carbamate complexes and propylated (RADOJEVIC *et al.*, 1986) for GC AAS (gas chromatography/atomic absorption spectrometry) detection, or reextracted into acidic aqueous solution (MIKAC and BRANICA, 1992) for the electrochemical detection (DPASV, differential pulse anodic stripping voltammetry). Total lead in mussels is measured by DPASV after acid (HNO_3 + $HClO_4$) digestion.

A previous study (MIKAC and BRANICA, 1992) in the Sibenik area showed that the gasoline station represents a continuous source of organolead compounds. Mussels were collected in urban harbours (towns of Sibenik, Zadar and Split) and in the unpolluted Krka estuary (Sibenik area). Soft mussels tissue contained alkyllead compounds in the concentration range of < 0.1-14.3 ngPb/g w.w. Triethyl, trimethyl and tetraethyl lead derivatives were detected. The highest concentrations were found in mussels collected in front of the gasoline stations, but a low level of these compounds (< ngPb/g) was also found in samples from the unpolluted area.

Alkyllead compounds make only a small portion (0.1-1%) of the total lead in mussels, similarly as it was the case for surface waters (MIKAC and BRANICA, 1994). Bioconcentration factors (BF) for organolead and the total lead between mussels and seawater are calculated (Table 1). Generally, BF are lower for organic than for the total lead, except in mussels collected in front of the gasoline station. Obviously, going from the pollution source of organic lead BF is decreasing for the organic lead (as a consequence of decreasing organolead level in the water phase), but is increasing for the total lead.

Table 1. Bioconcentration factors for organic and total lead between mussels and seawater

Sampling site and date	Bioconcentration factor for lead compounds ($ngPbkg_{-1}$ w.w. in mussels/$ngPbl_{-1}$ in seawater) OrgPb	TotPb	Ref.
February 1992			
SI GS	2860	2260	This
SI H1	1400	13380	work
September 1993			
SI GS	>1200	4740	"
SI H1	> 800	5720	
SI H2	>1600	5510	
April 1994			
ST GS	1200	1044	"
ZD H	>1000	5570	
SI E1	-	7-11000	1
SI E2	-	16-25000	"

I-Sibenik, ST-Split, ZD-Zadar
GS-gasoline station, H-harbour, E-Krka estuary
Ref.: 1- D. Martincic et al., Sci. Total. Environ., 119 (1992) 211.

REFERENCES:

M. RADOJEVIC, A. ALLEN, S. RAPSOMANIKIS, R.M. HARRISON, *Anal. Chem.* 58 (1986) 658-661.

N. MIKAC and M. BRANICA, *Anal. Chim. Acta*, 264 (1992) 249-258.

N. MIKAC and M. BRANICA, *Chem. Speciat. Bioavail.* 4 (1992) 109-115.

N. MIKAC and M. BRANICA, *Sci. Total. Environ.*, 154 (1994) 39-46.

C

C

FLUORESCENCE OF AGEING EXTRACELLULAR PRODUCTS OF *SKELETONEMA COSTATUM*

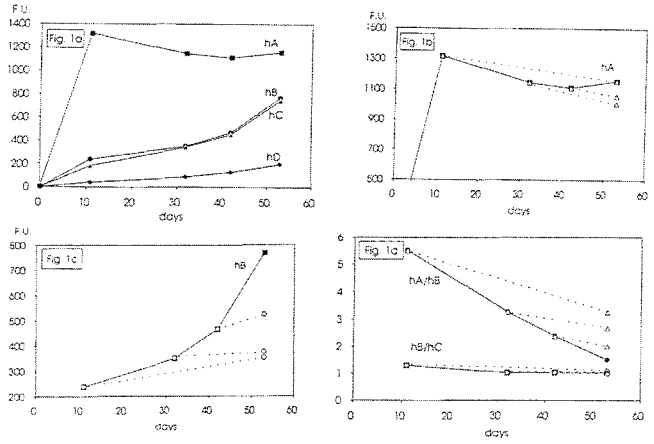
MINGAZZINI M.[1], COLOMBO S.[2] and PREVITALI L.[1]

[1] Water Research Institute, CNR, Via della Mornera 25, 20047 Brugherio (Mi), Italy
[2] University of Milan, Dept. of Biology, Via Celoria 26, 20133 Milano, Italy

The extracellular organic matter (EOM) released in dissolved state in the water by phytoplankton was characterized using the synchronous fluorescence spectroscopy. This technique, due to its high sensitivity and selectivity, allows the spectral resolution of different compounds present in multicomponent mixtures of dissolved organic matter (VO-DINH, 1978; CABANISS and SHUMAN, 1987). The aim was to verify if quali-quantitative variations observed on the ageing EOM produced by algal cultures were related to changes in algal production rather than to chemical transformations of the released products. *Skeletonem costatum*, isolated from Adriatic Sea, was cultured in laboratory (EPA, 1974). The EOM produced was analyzed during a 53 days experiment, using a Spex-FluoroMax fluorimeter, scanning synchronously a wavelength range from 250 to 500 nm, with constant Δwl (25 nm) between ex and em monochromators. Samples were taken from the *S. costatum* culture at 11, 32, 42, 53 days of growth and filtered (0.45 µm). The filtered medium, containing the dissolved EOM, was kept ageing in the same light and temperature conditions of the producer culture. All samples were analyzed at the sampling time and at the 53rd day. The fluorimetric analysis provided spectra characterized by a main peak (A) at an excitation wavelength of 276 nm and a series of secondary peaks (B, C, D) located between 330 and 430 nm. Spectra of the differently aged culture-EOM (C-EOM) showed quantitative variations of the different components produced, as shown in Figure 1a (F.U.= fluorescence units). The fluorescence intensity of the first peak (hA), which reaches high values at the day 11, tends successively to decrease slightly, while the intensity of peaks >300 nm (hB, hC, hD) increase constantly during the 53 days (Fig 1a). The same trend in fluorescence was already described in previous ageing experiments made on a number of different algal species in culture (MINGAZZINI *et al.*, 1994; in press). In those cases, however, it was not clarified if the series of the higher wavelengths peaks, with respect to the first peak, may represent the fluorimetric response of different extracellular compounds produced in stationary growth phase, rather than a chemical transformation of the algal products already present in the medium.

The fluorescence values measured on the ageing filtered medium-EOM (M-EOM) are shown in Figure 1b and 1c. C-EOM and M-EOM are represented by uninterrupted and dotted lines, respectively. The decrease in fluorescence intensity of the first peak (Fig. 1b) is similar or even greater in the M-EOM compared to C-EOM. Conversely, the increase in fluorescence intensity of peaks >300 nm is constantly much lower in M-EOM than in C-EOM, as shown in Fig. 1c for hB. Since in M-EOM the decrease of hA is not accompanied by an increase of hB, hC, hD equal to that observed in C-EOM, the fluorescence enhancement is probably linked to the algal production in the stationary growth phase. The decrease of hA may be the result of slow photodegradation processes (CHEN and BADA, 1992) of products released by the actively growing culture.

The ratios hA/hB and hB/hC, calculated on C-EOM and on M-EOM in the 53-day experiment, are shown in Figure 1d. The ratio between the first two peaks (hA/hB), which decrease in time, was previously proposed (MINGAZZINI *et al.*, 1994; in press) to describe the quali-quantitative variation of the extracellular compounds released during the algal growth phases. The ratios between the last series of peaks (hB/hC in Figure 1d), which tend instead to remain constant in time, were used to describe the spectral features linked to the producer algal species. The comparison of the C-EOM and M-EOM supports the suggestions of MINGAZZINI *et al.*. The hB/hC ratio from both C-EOM and M-EOM remains in fact constant in time, indicating that the extracellular products released in the stationary phase from a monospecific culture do not vary qualitatively, while the decrease of the hA/hB ratio mostly reflects changes in production activity rather than chemical transformations of the released products. The differences observed comparing C-EOM to M-EOM hA/hB (Figure 1d) are in fact mainly related to the missing production in all M-EOM samples (from day 11 to 53), as shown in Figure 1c.



REFERENCES

CABANISS S.E. and SHUMAN M.S., 1987. Synchronous fluorescence spectra of natural waters: tracing sources of dissolved organic matter. *Mar. Chem.* 21: 37-50.

CHEN R.F. and BADA J.L.,1992. The fluorescence of dissolved organic matter in seawater. *Mar. Chem.* 37: 191-221.

EPA, 1974. Marine algal assay procedure. Bottle test, eutrophication and lake restoration branch. Pacific Northwest Environ. Protect. Lab., Corvallis, OR.

MINGAZZINI M., FERRARI G.M. and COLOMBO S., 1994. Caratterizzazione fluorimetrica della sostanza organica extracellulare prodotta dal fitoplancton. XXV Congresso Soc.It.Biologia Marina, Sassari - Alghero, maggio 1994.

MINGAZZINI M., COLOMBO S. and FERRARI G.M., in press. Spectrofluorimetric techniques application to study marine mucilages in the Adriatic Sea: preliminary results. *Sci. Tot. Environ.*

VO-DINH, T., 1978. Multicomponent analysis by synchronous luminescence spectrometry. *Anal. Chem.*, 50: 396-401.

VERTICAL CARBON FLUXES DURING SUMMER IN THE NORTHERN AND CENTRAL ADRIATIC SEA

J.-C. MIQUEL, J. LA ROSA, T.F. HAMILTON and S.W. FOWLER

IAEA - Marine Environment Laboratory, P.O. Box 800, MC98012 Monaco

Within the framework of the EEC-sponsored ELNA (Eutrophic Limits of the Northern Adriatic) programme, vertical fluxes of particles and carbon were measured for short periods during mid-July 1993 in the Northern and Central Adriatic Sea. The central goal of ELNA is to assess the carbon assimilation capacity of the northern Adriatic in order to determine acceptable limits to its eutrophication. Besides studying particle export from the pelagic environment, the programme is oriented towards developing an oceanographic model to derive the mechanisms controlling nutrient and carbon budgets and fluxes for the northern part of the Adriatic.

A drifting sediment trap was deployed for two-24 hour periods in the Jabuka Pit and Po river plume areas during the ELNA3 cruise. The sediment trap used was a PPS5-Technicap model with a conical collection jar and a 1 m^2 surface opening fitted with a honey-comb baffle. The trap was positioned below the euphotic layer or a few meters above the bottom. The collection cup was filled with a 2% buffered formaldehyde solution before deployment to prevent grazing by swimmers. Before desalting and freeze-drying, the swimmers were removed by hand-picking under a dissecting microscope. During each deployment suspended particles were sampled near the drifter for analysis of carbon and nitrogen. Water samples were collected using Niskin bottles and filtered on precombusted fiberglass filters (Whatman GF/F). Particulate carbon and nitrogen were analyzed with a CHN Heraeus analyzer following protocols described by MIQUEL *et al.* (1994). POC samples were pre-treated with 1 M phosphoric acid prior to combustion to remove carbonate. Only total carbon was measured in the suspended particles.

A vertical profile in the Jabuka Pit showed a marked increase in particulate carbon between 50 and 70 m. The nitrogen content was also higher at these depths, especially at 50 m. This range corresponded with the CTD fluorescence maximum (50-70 m) associated to the highest phytoplankton biomass. In contrast, in the northern sector of the Adriatic suspended particulate carbon was very high in surface waters and then decreased with increasing depth. Particulate carbon concentrations were always higher than those measured at corresponding depths in the Jabuka Pit, and appeared to be of biological origin as indicated by the high nitrogen concentrations. The highest C and N content in central and northern Adriatic waters were 76 and 13 µg l^{-1}, and 438 and 59 µg l^{-1}, respectively. Integrated carbon values for the water column at both sites were 5.5 g m^{-2} (0-100 m, Jabuka site) and 4.1 g m^{-2} (0-27 m, Po outflow).

The downward particle, organic C, N and fecal pellet fluxes are reported in Table 1. Near the mouth of the Po river, mass flux was roughly 13 times higher than that measured in the oligotrophic waters over the Jabuka Pit. Carbon (total and organic) and nitrogen fluxes were also higher in the northern sector by a factor of 5 to 6 times. Furthermore, the sinking particles were different in nature at the two sites. Off the Po outflow, the particulate material was characterized by a large amount of amorphous, mucoid marine floc in which were suspended many small zooplankton fecal pellets (Table 1). In contrast, the sample from the Jabuka Pit was translucent and contained only few fecal pellets and detrital particles. In the north, large fish fecal pellets contributed significantly to the downward mass and carbon flux. Their numerical flux was only 36 pellets m^{-2} d^{-1} but because of their large size (mean length 3 mm, diameter 1.5 mm), they accounted for approximately 30% of mass flux and 60% of carbon flux. If fish pellets are not considered, then the remaining zooplankton fecal pellets represented only 6 to 10 % of the carbon flux at both sites.

Location (St. no.)	Lat.Long.	Date	Trap Depth	Bottom Depth	Mass	C.org. (mg $m^{-2}d^{-1}$)	Flux N	Fecal Pellets (No. $m^{-2}d^{-1}$)
Jabuka Pit (St. 3)	42°52.28'N 14°50.43'E	14-15/7	100	242	10	2.5	0.3	1.6×10^3
Po outflow (St. 172)	44°56.05'N 13°01.11'E	24-25/7	27	35	127	11.5	1.6	3.7×10^4

Table 1. Particle flux in the Adriatic Sea measured over 24 hours with a drifting sediment trap, July 1993.

Carbon flux in central Adriatic was, as for the other measured parameters, very low indicating the oligotrophic nature of these waters during summer. Furthermore, the total carbon sedimenting per day represented only 0.05% of the carbon pool in the water column above the trap, confirming that there was virtually no export from surface waters at that time. On the contrary, carbon flux in the northern Adriatic was much greater, although the fluxes are not particularly high for a coastal environment. Sinking particulate carbon represented 0.35% of the carbon standing stock per day in the water column suggesting a mesotrophic system was present during July.

Data obtained in 1993 will be complemented with similar results from a 1994 summer cruise. Both sets of data should help to understand interannual variations in carbon flux in the Adriatic. Given that one of the main objectives of ELNA is to construct a carbon budget for the northern Adriatic, it is also essential to understand long-term temporal changes in the downward flux of particle carbon. Thus, a time-series sediment trap has been moored in central Adriatic from which we expect to obtain at least one complete year of vertical particle flux data.

ACKNOWLEDGEMENTS

The IAEA Marine Environment Laboratory operates under a bipartite agreement between the International Atomic Energy Agency and the Principality of Monaco. Financial support from S.O.P.RO.MAR, Italy as part of the EEC STEP Programme "ELNA" is gratefully acknowledged.

REFERENCES

MIQUEL J.C., FOWLER S.W., LA ROSA J. and BUAT-MENARD P., 1994. - Dynamics of the downward flux of particles and carbon in the open northwestern Mediterranean Sea. *Deep Sea Res.* 41, 243-261.

SYNERGETIC ADSORPTION IN ELECTROCHEMICAL DETERMINATION OF METAL IONS IN SEAWATER

Marina MLAKAR, Ivan CULJAK and Marko BRANICA

Center for Marine Research Zagreb, Ruder Boskovic Institute, P.O.B 1016, 41000 Zagreb, Croatia

To enable a simple and convenient electrochemical determination of metal-ion concentrations in natural waters it is necessary to find a system of ligands which can complex them and form a highly hydrophobic specia strongly adsorbed at the mercury drop electrode surface. In that way the enhancement of metal-ion concentration occurs in the adsorption layer at the electrode surface then in the bulk of the solution. Such an approach is interesting because metal-ions in natural waters are present in a very low concentrations and as complexes with various organic substances. Due to that they are specifically adsorbed at different surfaces (sediments or particles in seawater and fresh waters).

So-called synergetic adsorption of few metal ions (uranyl-ion, copper(II)) at the mercury drop electrode surface was studied. The method is compared with the simple anion-induced adsorption (MLAKAR *et al.*, 1990). Synergetic adsorptive accumulation is based on the principles of synergetic solvent extraction that is from the aqueous to the organic phase. The phenomenon of synergism is described as a manifold enhancement of the metal-ion extraction from the aqueous solution to the organic by the system of two ligands which form a hydrophobic complex species with the metal-ion. Basic conditions which must be fulfilled are :

(i) the neutralization of the charge at the central metal-ion by forming a chelate complex;

(ii) the second ligand, so-called synergist, which is not soluble in the water solutions and therefore is very hydrophobic, reacts with the chelate complex and substitutes all remained water molecules from the coordination sphere in the central metal-ion;

(iii) the convenient spatial arrangement of ligands around the central metal-ion;

(iv) the accomplishment of maximum coordination number of the central metal-ion.

Such complexes become extremely hydrophobic and they are formed only in the organic phase.

As the adsorption layer at the mercury drop electrode surface can be very good replacement for the organic phase, due to its highly hydrophobic behaviour, it can serve as a good replacement for the organic phase. Therefore, the hydrophobic mixed ligand complex will be formed only in the adsorption layer at the electrode surface (MLAKAR and BRANICA, 1988). In that way the concentration of the metal-ion at the electrode surface will be manifold enhanced and it will be possible to measure very low concentration levels of metal-ions present in natural water systems. In the adsorbed state the metal-ion remains to be electroactive with the increased overpotential and it responds well to various voltammetric excitation signals.

In this study it will be presented a synergetic adsorption of uranyl-ion mixed ligand complex with 2-thenoyltrifluoroacetone and tributylphosphate and copper(II)-ion mixed ligand complex with 1,10-phenanthroline and tributylphosphate.

The effect of synergetic adsorption in the system UO_2^{2+}-TTA-TBP was obtained at pH about 3.6. After the accumulation at -0.15 V very sharp and pronounced peak was registered at about -0.5 V vs. Ag/AgCl. By this system of ligands the lowest detection limit by linear sweep voltammetry after the accumulation of 10 minutes at -0.15 V was found to be $(1.1 \pm 0.2)*10^{-10}$ mol/l. The results of uranyl ion measurements in natural water samples of saline and fresh waters will be presented.

By the system Cu(II)-Phen-TBP (CULJAK *et al.*, 1994) the situation was more complicated. The mixed ligand complex with copper(II)-ion and the synergetic adsorption were obtained in narrow pH range between 9.5 and 10. In spite that the phenanthroline molecules chelate copper(II)-ion in a broad range, they do not neutralize the charge of the Cu-chalate complex. The charge of Cu^{2+}-$phen_2$ complex is neutralized by two hydroxide ions in pH range between 9 and 10.5, in accordance with the calculated distribution curves of Cu(II)-ion. After that step TBP molecules in the adsorption layer form a mixed ligand complex $Cu(OH)_2Phen_2TBP$. The reduction peak was registered after the accumulation at -0.3 V at the potential about -0.6 V. A detection limit of Cu(II)-ion by square-wave voltammetry (after the accumulation of 10 minutes at -0.3) was found to be $(1.2 \pm 0.2)*10^{-10}$. The concentration of copper(II)-ion was detected in fresh and saline water samples from the Rasa Bay and Rasa River.

REFERENCES

M. MLAKAR, M. LOVRIC and M. BRANICA, 1990. *Collect. Czech.Commun.* 55 : 903.

M. MLAKAR, and M. BRANICA, 1988. *J. Electroanal. Chem.* 257: 269.

I. CULJAK, M. MLAKAR and M. BRANICA, 1994. *Anal. Chim. Acta*, in press.

DÉTERMINATION DES COMPOSÉS PHOSPHORÉS PAR TRAITEMENT SÉQUENTIEL. APPLICATION AUX SÉDIMENTS ESTUARIENS RÉCENTS EN MÉDITERRANÉE ORIENTALE

S. NOUREDDIN, H. ALDASH & A.K. YOUSSEF

Institut de Recherches Marines, B.P. 2242, Université de Tichrine, Lattaquié, Syrie

Le phosphore existe dans les sédiments estuariens récents sous trois formes principales : organiques (phospholipides, acides nucléaires, phosphoglucides,..), inorganiques simples ($H_2PO_4^-$, HPO_4^{2-}, PO_4^{3-}) et polyphosphates. Le bilan de ces trois formes peut être dressé par une analyse faisant appel à un traitement séquentiel. Dans le cadre d'un programme intégré pour mieux connaître l'écosystème estuarien en Syrie, nous avons effectué ce travail sur les estuaires des rivières Al-Kabir Al-Chimali (ERKC), Al-Sin (ERS), Al-Hassein (ERH) et Al-Abrache (ERA). La rareté des données géochimiques et océanographiques concernant les différentes rivières syriennes, débouchant sur les côtes Est de la mer Méditerranée, justifie en outre la réalisation de ce type de travail.

Les résultats présentés ont été acquis au cours de plusieurs sorties réalisées mensuellement entre janvier 1991 et février 1992 dans l'ERKC, et saisonnièrement dans les quatre estuaires précités. Les prélèvements ont été effectués manuellement en plongée autonome, et à l'aide d'un tube en PVC de 4.5 cm. de diamètre. La colonne sédimentaire étudiée est de 12 cm. d'épaisseur; les carottes sont découpées en tranches de 2 cm. d'épaisseur, séchées à l'étuve à 80°C, tamisées à 2 mm. et finalement gardées à l'obscurité jusqu'à leur analyse.

La détermination du phosphore organique et des orthophosphates dans les sédiments a été faite selon la technique d'ASPILA *et al.* (1976); cette technique consiste à diviser l'échantillon en deux sous-échantillons, l'un est pyrolysé à 450°C, puis traité avec HCl (1N), le phosphore organique est ainsi libéré en forme d'orthophosphates; l'autre sous-échantillon est traité directement avec HCl (1N), pour libérer uniquement les orthophosphates. Une détermination spectrophotométrique des orthophosphates est ensuite réalisé selon la méthode de MURPHY & RILEY (1962); le phosphore organique est alors calculé par différence. Le polyphosphore a été déterminé dans les résidus de sous-échantillons après avoir déterminé leur contenu en phosphore organique et orthophosphates. Les polyphosphates ont été déterminés selon une méthode similaire à celle de KOROLEFF (1983); elle consiste à hydrolyser les polyphosphates sédimentaires à 80°C, en présence d'acide sulfurique (0.5M); les polyphosphate sont ensuite déterminés dans l'extrait acidique, en forme d'orthophosphates, selon la technique de MURPHY & RILEY (1962).

L'étude annuelle, effectuée sur l'ERKC, indique que les orthophosphates ainsi que le phosphore organique présentent des variations saisonnières en liaison avec le cycle biologique de l'écosystème étudié; des teneurs relativement importantes en ces matériels ont été également enregistrées en début de période hivernale en raison d'apports externes. Les polyphosphates ne présentent pas, par contre, des variations saisonnières notables et leur distribution verticale est plutôt homogène; ceci indique que leur accumulation dans les sédiments estuariens étudiés n'est liée ni au cycle biologique de l'estuaire, ni à son cycle hydrologique.

Le phosphore inorganique en forme d'orthophosphates représente la partie majeure au sein du phosphore sédimentaire total (entre 45 et 87%), alors que le phosphore organique représente entre 1 et 43% du phosphore sédimentaire total (et uniquement entre 5 et 10% pour 53% des échantillons sédimentaires étudiés). Le polyphosphore sédimentaire repésente moins que 20% du phosphore sédimentaire total.

La comparaison de nos valeurs avec la littérature internationale indique une certaine pauvreté des sédiments étudiés, concernant leur contenu en différents composés phosphorés étudiés. Une autre comparaison entre les résultats concernant les différents estuaires syriens étudiés témoigne que chacun d'eux possède des caracatéristiques bien particulières. Une accumulation relativement importante des polyphosphtes a été, par ailleurs, mise en évidence dans les estuaires de la partie sud des côtes syriennes sur la Méditerranée.

REFERENCES

ASPILA K.I., AGEMIAN H. & CHAU A.S.Y., 1976. A semi automated method for the determination of inorganic, organic and total phosphates in sediments. *Analyst*, 101: 187-197.

KOROLEFF F., 1983. Determination of phosphorus *in:* "Methods of Seawater Analysis"; Edited by K. Grasshoff, M. Ehrhardt & K. Kremling; Second, Revised and Extended Edition; Verlag Chemie, 125-139.

MURPHY J. & RILEY J.P., 1962. A modified single solution method for determination of phosphates in natural water., *Anal. Chim. Acta*, 27: 31-36.

C

ELECTROCHEMICAL DETERMINATION OF THE METAL COMPLEXING CAPACITY

D. OMANOVIC, I. PIZETA, Z. PEHAREC and M. BRANICA

Center for Marine Research Zagreb, Rudjer Boskovic Institute, P. O. Box 1016, 41001 Zagreb, Croatia

Metal complexing capacity (MCC) is the parameter of a seawater which shows in the indirect way the amount of ligands which form inert complexes with particular heavy metal and can be of interest in characterization of the purity of seawater. Its determination needs a measuring procedure and a data treatment, which will be discussed (RUZIC, 1982) and shown in Figure 1.

Depending on the working electrode used, we distinguish two procedures, first using static mercury drop electrode (SMDE) assembly and the second using thin mercury film glassy carbon disk electrode (TMFGCDE) assembly (OMANOVIĆ *et al.*, 1994).

Concerning SMDE assembly, from cathodic measurements in 2-3 orders of magnitude higher concentration range than found in natural seawater samples (5×10^{-5} mol l^{-1}) with model solutions with copper (II) and ethylenediamine-tetraacetic acid (EDTA), it is concluded that MCC determination would not be possible because peaks of free and labile complexed copper and the inert one are so close that no deposition potential was available where only the free copper would be reduced and accumulated for ASV technique which is necessary in low concentration range. Triton-X-100 (T-X-100) separates the waves of free and inert complexed copper. In order to find the best conditions for Cu CC determination, dependencies of Cu oxidation peak current height as well as Cu EDTA reduction peak potentials on concentration of T-X-100 and adsorption time and adsorption potential have been measured. Also the linearity of standard additions of copper in presence of T-X-100 is checked.

Concerning TMFGCDE assembly, from cathodic measurements, it has been noticed that the separation of mentioned waves, was dependent on the thickness of the mercury film. When the film is thicker, these two waves are closer, approaching to the signals corresponding to the mercury drop electrode.

Pseudopolarograms of model solutions with copper (II) for both electrode assemblies are presented. They are the fingerprints of the measured solution and give us the answer about the accumulation potential, where only the free and the labile copper would be accumulated.

When comparing the TMFGCDE with the SMDE regarding MCC determination, we have to point out that TMFGCDE has the detection limit an order of magnitude lower. As a procedure it is simpler and needs no addition of chemicals to the sample. Because of the better stirring possibilities, the double layer is thinner which enables better distinguishing between labile and inert complexes and in that sense better MCC determination.

The limitations of that electrode assembly caused by cell wall adsorption will be presented. Advantages of SMDE are the renewal of the electrode surface which is important in the presence of strong surface active substances.

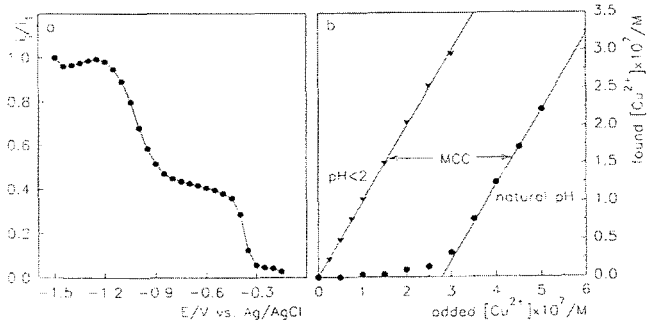


Figure 1. a) A pseudopolarogram of 3×10^{-7} M copper (II) in 0.55 M NaCl in the presence of 2×10^{-7} M EDTA. b) Metal complexing capacity determination

REFERENCES

I. RUZIC, 1982. Theoretical aspects of the direct titration of natural waters and its information yields for trace metal speciation, *Anal. Chim. Acta*, 140 99-113.

D. OMANOVIC, Z. PEHAREC, T. MAGJER, M. LOVRIC and M. BRANICA, 1994. Wall-jet electrode system for anodic stripping voltammetry, *Electroanalysis*, in press.

A PRELIMINARY STUDY ON THE NUTRIENTS IN THE AL-KABIR AL-SHIMALI RIVER ESTUARY (SYRIA)

M. OMRAN, S. NOUREDDIN & A.K. YOUSSEF

Marine Research Institute, P.O.Box 2242, Tishreen University, Lattakia, Syria

In spite of the presence of several, permanent and seasonal, rivers in the Syrian coastal region, there is not, as far as we know, any study on their different hydrochemical properties, especially concerning the seasonal variations of nutrients in the estuarine waters, and their effect on the marine coastal ecosystems. Al-Kabir Al-Shimali river is the longest Syrian coastal river (96 km.); its estuary is situated in the south of Lattakia city. The tidal regime of the Al-Kabir Al-Shimali river estuary (KSRE) is low, as it is the case of the Eastern Mediterranean river estuaries, and the intermixing estuarine zone is relatively limited.

This research aims to make a first series of inspections on the nutrients levels in the KSRE, and we hope to develop it later to cover hydrochemical and biological cycle in the KSRE and neighboring coastal waters.

The sampling program is carried out between January 1991 and February 1992. Nutrients were determined in surface waters only. Analyses of nutrients were based on standard spectrophotometric methods (AMINOT & CHAUSSEPIED, 1983). The indophenol blue technique was used for ammonium determination, while nitrite and nitrate were analyzed as a pink azo compound before and after reduction of the samples on cadmium columns treated with copper sulfate. Orthophosphates (reactive phosphorus) were determined by molybdenum-blue technic. Salinity and temperature were measured in situ with a S-C-T-meter (YSI-33); an ulterior measurement of salinity were performed by titrametric method of Knudsen.

The salinity, of the studied estuarine waters, were ranged between 0.0 and 23‰, and the temperature between 8 and 31°C for the whole annual cycle. Nitrates are the more abundant nitrogenous nutrient (1.7 to 37.8 umol/l), and they have the wider seasonal variations. Ammonia concentrations ranges between 0.3 and 5.2 umol/l. Nitrite concentrations were below 1.2 umol/l. The concentration of orthophosphates is usually smaller than 1.7 umol/l. The concentrations of all nutrients decrease in the sea outside the river estuary.

Nutrients concentrations, which studied in the KSRE waters, showed very different variations according to the season and to the considered nutrient (Figure 1). Nitrates and orthophosphates were highest in winter and decreased in spring and summer. Ammonium and nitrites show relatively important concentrations in summer also, after a distinct decrease in April 1991.

The behaviour of nutrients in the intermixing estuarine zone, as it concerns their seasonal variations, and the biological activity of the estuarine ecosystem. The main tendency is accumulation during winter and removal during summer.

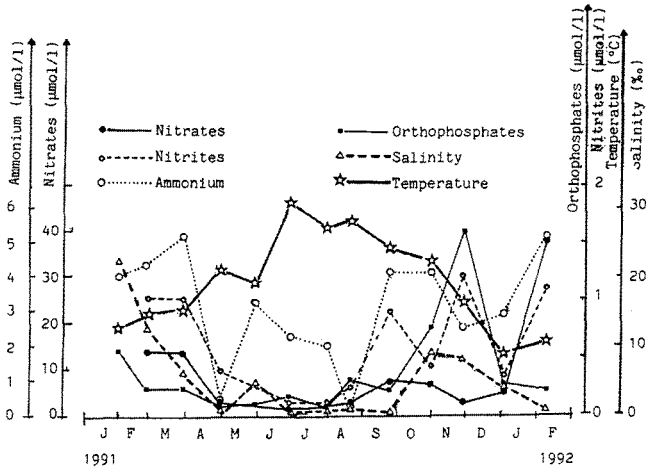


Figure 1: Seasonal variations of nutrients, salinity and temperature in the Al-Kabir Al-Shimali river estuarine waters.

REFERENCES

AMINOT A. & CHAUSSEPIED M., 1983. Manuel des analyses chimiques en milieu marin., CNEXO, Brest, BNDO/Document., 393p.

INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF THE BED LOAD SEDIMENTS, SAMPLED FROM THE ROMANIAN DANUBE RIVER, DURING 1993

Ana PANTELICA[1], Maria SALAGEAN[1] and Iulia I. GEORGESCU[2]

[1] Institute of Physics and Nuclear Engineering, Bucharest, Romania
[2] University "Polytechnica", Fac. of Chem. Techn., Bucharest, Romania

In a previous paper of GEORGESCU *et al.* (1979) it has been outlined the importance of the stable macro and micro elements concerning the transport and transfer of the radionuclides between water, suspended matter, sediments and biota. In this paper, samples of sediments from the significant verticals of the Romanian Danube river were collected as follows : Svinitza and Orsova (entrance of Danube river in Romania), before the Turnu-Severin dam and there after at Bechet in front of the Nuclear Power Plant KOZLODUI (kms. 705 and 678).

Samples were dried in an electric oven at 105°C, then homogenized in an agath mortar. Chemical analyses were performed for Al, Mg, Mn, P, Si and Ti. Loss of weight at 1000°C varied between 13.30% at Svinitza to 3.64% at Bechet km 678. For INAA, about 100 mg of each sediment sample in thin aluminium foil together with the Reference Materials were irradiated at the VVR-S Reactor of Bucharest, at a flux of 10^{11}-10^{12} n/cm^2.s. The measurements were performed with a HPGe detector of 2.2 keV at ^{60}Co coupled to a multichannel analyser.

At Svinitza-Orsova, the highest values are to be observed concerning the As, Br, Sb, Rare Earths, Th, U, Zn, while after Turnu-Severin dam, the chemical pollution is rapidly decreasing (Table 1).

Table 1. Instrumental Neutron Activation Analysis and Chemical Analysis* of the sediment samples from the Danube river during 1993.

Element	Svinitza (8.04.93)	Orsova (8.04.93)	Turnu-Severin (9.04.93)	Bechet (km 705) (17.04.93)	Bechet (km 687) (17.04.93)
Al* (%)	7.59 ± 0.23	7.30 ± 0.22	4.76 ± 0.14	4.04 ± 0.12	2.85 ± 0.09
As (ppm)	25.5 ± 0.50	23.6 ± 0.50	6.10 ± 0.30	7.30 ± 0.30	7.50 ± 0.30
Ba (ppm)	347 ± 41	530 ± 50	417 ± 40	364 ± 36	363 ± 35
Br (ppm)	5.5 ± 0.4	6.8 ± 0.6	1.8 ± 0.4	1.0 ± 0.3	0.9 ± 0.3
Ca (%)	2.18 ± 0.20	5.05 ± 0.25	4.57 ± 0.22	4.15 ± 0.20	1.78 ± 0.11
Ce (ppm)	72.5 ± 1.5	67.5 ± 1.4	24.3 ± 0.6	27.5 ± 0.6	18.1 ± 0.5
Co (ppm)	18.3 ± 0.6	18.6 ± 0.6	11.5 ± 0.3	8.7 ± 0.3	6.1 ± 0.2
Cr (ppm)	161 ± 6	161 ± 5	349 ± 7	56 ± 1	99 ± 2
Cs (ppm)	9.5 ± 0.5	9.1 ± 0.5	2.5 ± 0.2	1.7 ± 0.2	0.9 ± 0.1
Eu (ppb)	990 ± 85	867 ± 81	509 ± 45	566 ± 52	418 ± 40
Fe (%)	4.34 ± 0.06	4.11 ± 0.06	2.24 ± 0.04	1.52 ± 0.02	1.16 ± 0.02
Hf (ppm)	4.4 ± 0.2	2.8 ± 0.2	2.0 ± 0.1	1.9 ± 0.1	1.5 ± 0.1
K (%)	1.70 ± 0.05	1.60 ± 0.05	2.24 ± 0.07	0.95 ± 0.04	0.92 ± 0.04
La (ppm)	26.1 ± 0.4	31.7 ± 0.5	9.2 ± 0.2	13.0 ± 0.3	7.8 ± 0.2
Lu (ppb)	940 ± 90	326 ± 20	217 ± 12	152 ± 9	146 ± 8
Mg*(%)	1.23 ± 0.04	0.89 ± 0.03	0.65 ± 0.02	0.52 ± 0.02	0.52 ± 0.02
Na (%)	0.57 ± 0.01	0.50 ± 0.01	1.37 ± 0.02	1.07 ± 0.01	0.93 ± 0.01
Mn*(ppm)	387 ± 11	542 ± 15	775 ± 22	620 ± 20	620 ± 20
Rb (ppm)	113 ± 10	99 ± 9	57 ± 5	44 ± 4	39 ± 4
P* (ppm)	131 ± 3	611 ± 13	350 ± 10	305 ± 10	305 ± 10
Sb (ppm)	4.4 ± 0.2	4.0 ± 0.2	0.3 ± 0.1	0.3 ± 0.1	0.3 ± 0.1
Sc (ppm)	13.8 ± 0.1	13.4 ± 0.1	9.2 ± 0.1	5.2 ± 0.1	3.9 ± 0.1
Si* (%)	20.22 ± 0.40	19.70 ± 0.40	33.63 ± 0.67	31.61 ± 0.63	37.25 ± 0.75
Sm (ppm)	6.54 ± 0.06	5.53 ± 0.05	2.17 ± 0.02	2.47 ± 0.03	1.50 ± 0.02
Ta (ppb)	850 ± 130	650 ± 127	356 ± 72	476 ± 95	242 ± 60
Tb (ppb)	1000 ± 150	730 ± 156	410 ± 82	375 ± 74	196 ± 41
Ti* (%)	0.28 ± 0.01	0.23 ± 0.01	0.48 ± 0.01	0.39 ± 0.01	0.45 ± 0.01
Th (ppm)	27.0 ± 0.2	10.3 ± 0.2	4.4 ± 0.1	3.9 ± 0.1	2.2 ± 0.1
U (ppm)	3.6 ± 0.5	2.4 ± 0.4	1.3 ± 0.2	1.2 ± 0.2	0.8 ± 0.2
Yb (ppm)	5.3 ± 0.6	2.4 ± 0.2	1.9 ± 0.1	1.1 ± 0.1	1.0 ± 0.1
Zn (ppm)	356 ± 20	539 ± 45	142 ± 12	80 ± 8	49 ± 5

ACKNOWLEDGEMENT. The authors are indebted to Dr.eng. C.BONDAR of the National Institute of Meteorology and Hydrology - Bucharest, who sampled us the bed load sediments.

REFERENCES

GEORGESCU I.I., DEMIAN N., BUTUCEANU E. and BANU C. - 1979 - On the radioactivity of the Danube water and sediments during 1977. International studies on the radioecology of the Danube river, IAEA TEC DOC - 219, pp.131-144.

A STUDY OF THE APPEARANCE OF MUCILAGINOUS MASSES IN THE WATERS OF THE NORTHERN ADRIATIC COASTLINE FROM 1988 TO 1992

Nunzio PENNA[1], Antonella DI PAOLO[1], Antonella PENNA[2]

[1] Cattedra di Microchimica, Università di Urbino, Urbino (PS), Italy
[2] Centro di Biologia Ambientale, Università di Urbino, Urbino (PS), Italy

This paper presents research carried out during the five-year period between 1988 and 1992 on the waters along the coastline of the Marche, a region of Italy, situated on the western shores of the Adriatic sea. These five years were of unique interest due to the presence of mucilaginous masses on the water surface.

The presence of mucilaginous masses in the area of the Northern Adriatic between Istria and Ancona is a well-known phenomenon, with the first records dating back to 1729. This material tends to appear at widely-spaced time intervals of up to twenty or thirty years (FONDA UMANI *et al.*, 1989) and only rarely does it appear on the surface for two or three years in succession. A study of this phenomenon in the years considered ('88-'92) thus seemed of particular interest, since in this period the mucilaginous masses appeared in three different years (1988-1989-1991). The mucilage appeared neither on the sea bottom nor along the water column in the years 1990 and 1992. Many hypotheses have been put forth regarding the formation of this gelatin-like matter. A likely hypothesis is that benthic diatoms, under certain climatic conditions (such as lack of wind, calm seas, elevated water temperatures) which can appear as early as the first months of spring, give rise to aggregations of mucilaginous particles along the water column which tend to rise to the surface. The level of nutrients in the water, which is related to the amount of rainfall and flow of river water, seems to have a certain impact on this phenomenon, in that it can lead to alterations or imbalances in the nitrogen-phosphorus ratio. Mucilage is present in various morphological forms, from very small amorphous aggregations (the so-called "marine snow"), to strips of various lengths or large "flakes" (HERNDL and PEDUZZI, 1988). Mucilage is often present in the form of sea snow on the sea bed, especially in the open sea (20 to 30 miles from the coast), but does not normally form masses or rise to the surface.

The research carried out in the years considered in this report has permitted the evaluation of the time required for the appearance and the spreading of mucilaginous masses.

1988 : In the month of August, mucilages appeared "en masse" in the sea area between Istria and Ancona, for the first time since approximately 1930. The phenomenon continued until September.

1989 : In this year the phenomenon appeared with unusual intensity in the months of July, August and September. An examination of the time requirement for its appearance demonstrated that these mucilaginous masses are carried along the Marche coast by a North-South current which circles the Adriatic in a counter-clockwise direction. In this period, deaths of benthic organisms took place. Our research, however, ruled out the possibility of anoxic or hypoxic phenomena in these waters and the death of these organisms, for the most part molluscs, was due to the vast amount of algal wastes which deposited on the sea bed (PENNA *et al.*,1993).

1990 : Absence of mucilages on the bottom and along the water column.

1991 : Reappearance of mucilages in a form different from that of the preceeding years. These mucilages appeared to rise to the surface almost simultaneously in the entire area of the Northern Adriatic from Istria to Ancona. No episodes of anoxia were reported for this year.

1992 : Absence of mucilages along the water column. Appearance of modest quantities of marine snow in small "flakes" on the sea bed.

Although the research carried out does not permit us to draw firm conclusions as to the causes leading to the production of mucilage, we are able to affirm that their appearance on the surface is fostered by certain climatic conditions and by reductions or imbalances in the levels of nutrients present in the sea water. Furthermore, it is of note that anoxic and hypoxic phenomena did not develop on the sea bed or along the water column in the presence of the mucilaginous masses (Fig. 1-2).

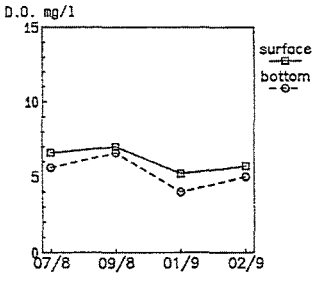


Fig.1 D.O. Variation on the surface and on the bottom in the August-September of 1989 along the Marche coast, from Tavollo to Cesano at 500 m from the coast.

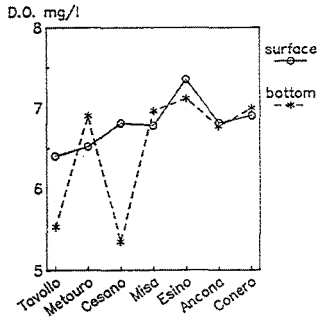


Fig. 2 D.O. Variation on the surface and on the bottom in the July of 1991 along the Marche coast, from Tavollo to Conero at 3000 m from the coast.

REFERENCES

FONDA UMANI S., GHILARDELLI E. and SPECCHI M., 1989 Gli episodi di "mare sporco" nell' Adriatico dal 1729 ai nostri giorni Ente regionale per l'Ambiente, Trieste, Italy.

HERNDL G. J. and PEDUZZI P., 1988 The ecology of amorphous aggregations (marine snow) in the northern Adriatic Sea. 1. General considerations P.S.Z.N.I. *Mar. Ecol.*, 9: 79-90.

PENNA N., RINALDI A., MONTANARI G., DI PAOLO A. and PENNA A., 1993 Mucilaginous masses in the Adriatic Sea in the summer of 1989. *Wat. Res.*, 12: 1767-1771.

C

ADSORPTION OF ACRYLIC AND POLYACRYLIC ACIDS ON DIFFERENT MODEL SURFACES IN SEAWATER

M. PLAVSIC and B. COSOVIC

Ruder Boskovic Institute, Center for the Marine Research Zagreb,
PO Box 1016, 41001 Zagreb, Croatia

In the past few decades considerable attention was paid to polyelectrolytes, substances of high molecular mass which are simultaneously electrolytes (LEEUWEN *et al.*, 1989).

In natural waters and soils the transport and bioavailability of many trace substances are influenced by the presence of not well characterized fraction of organic matter-humic substances which have many binding sites per molecule (mainly of carboxylic or phenolic type) and may be considered as polyelectrolytes.

Acrylic acid is by itself important for natural waters as it is known that some phytoplankton species especially the dinoflagellates along with the prymnesiophytes (KELLER *et al.*, 1989) are producers of - dymethylpropiothetin (DMPT) the osmotic pressure regulator. DMPT is enzymatically cleaved in seawater (or with alkaline solution to dimethyl sulfide (DMS) and acrylic acid. DMS was firstly identified by Hass (HASS, 1935) in the gaseous emissions of the marine red alga *Polysiphonia lanosa* and further on studied by many authors particullary after being recognized as a volatile sulfur compound important for the mass balance of atmospheric sulfur (LOVELOCK *et al.*, 1972). Acrylic acid is pointed out as a compound with antibiotic properties while the guts of penguins which consumed the algae (*Phaeocystis Pouchetii*) were found sterile because of the acrylic acid (SIEBURTH, 1960). It was found that acrylate is metabolised by a variety of bacteria. Polymerization of these material can not be excluded as it is known that acrylic acid polymerases to polyacrylic acid on standing.

In our work special attention is paid to the adsorption properties of these compounds with regard to their different molecular weights, in wide pH range and at different ionic strenghts, in the concentration range relevant for natural water systems aimed at elucidating the behaviour of these substances on the hydrophobic/hydrophilic interfaces in natural water systems.

The adsorption of acrylic acid, glutaric acid as well as polyacrylic acids (molecular weights (MW) = 2000, 5000 and 90 000) on the mercury surface by phase selective a.c. voltammetry at the potential of -0.6 V vs. Ag/AgCl reference electrode was investigated (Fig. 1.). The adsorption of these compounds were determined in the pH range 2 to 8 which is important because by changing the pH values the degree of the polyacrylic acids neutralization changes and influences adsorption. The adsorption of polyacrylic acids is pronounced at low pH values (pH = 2.0) while at higher pH values (pH = 7.0) they are not adsorbed at all regardless of the degree of polymerization. No effect of ionic strenght (0.01 M and 0.55 M NaCl) was estimated for adsorption of polyacrylic acid (MW = 2000 and MW = 5000) under experimental conditions. This indicates (MARINSKY, 1987) that these macromolecules are impermeable to salt (hydrophobic) which on the other hand determines its interaction with the hydrophobic surfaces.

The study of adsorption of acrylic acid and glutaric acid as possible monomers of polyacrylic acids at the mercury electrode have shown that even at low pH value glutaric acid is poorly adsorbed while acrylic acid is adsorbed more strongly than predicted by its hydrophobic properties defined through octanol/water distribution coefficient (REKKER, 1977).

The adsorption of polyacrylic acids on hydrophilic (mineral) surfaces was examined as well. The adsorption of polyacrylic acids and their monomers on hydrophobic and hydrophilic surfaces will be compared regarding its meaning for natural seawater.

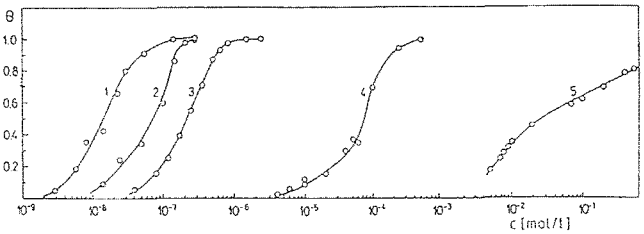


Figure 1. The adsorption isotherms of different polyacrylic acids in 0.55 M NaCl, pH 1.8. (1) PAA MW = 90000, (2) MW = 5000 (3) MW = 2000 and (4) acrylic acid and (5) glutaric acid. Adsorption time t = 60 s, potential E = -0.6 V vs Ag/AgCl reference electrode. Θ = degree of surface coverage .

REFERENCES

HASS. P., 1935. Investigation of the precursor for DMS, *Biochem. J.*, 29:1297-1299.

KELLER M.D., BELLOWS W.K., GUILLARD R.R.L., 1989. Dimethyl sulfide production in marine phytoplankton, in "Biogenic Sulfur in the Environment", *Am. Chem. Soc.*, 167-182.

LEEUWEN H.P., CLEVEN R., BUFFLE J., 1989. Voltammetric techniques for complexation measurements in natural aquatic media, *Pure and Appl. Chem.*, 61:255-274.

LOVELOCK J.E., MAGGS R.E., RAMUSSEN R.A., 1972. Atmospheric dymethyl sulphide and the natural sulphur cycle, *Nature*, 237:452.

MARINSKY J.A. 1987. A two-phase model for the interpretation of proton and metal ion interaction with charged polyelectrolyte gels and their linear analogues, in "Aquatic Surface Chemistry" (W. Stumm, ed.), Wiley, New York, 49-81.

REKKER R.F., 1977. The hydrophobic fragmental constants, Vol. 1. and 2., Elsevier, Amsterdam, pp. 347.

SIEBURTH J.McN., 1960. Acrylic acid, an "antibiotic" principle in Phaeocystis blooms in Antarctic waters, *Science*, 132:676-677.

LE PHOSPHATE EN MÉDITERRANÉE OCCIDENTALE : DONNÉES RÉCENTES ET RÉ-ÉVALUATION DE L'ÉVOLUTION TEMPORELLE AU SEIN DES EAUX PROFONDES

P. RAIMBAULT, P. CONAN et B. COSTE

Centre d'Océanologie de Marseille, Campus de Luminy, 13288 Marseille cedex 9, France

Les concentrations en sels nutritifs dans les eaux profondes méditerranéennes sont la conséquence d'un équilibre entre les entrées dans le bassin (eau atlantique superficielle, apports continentaux) et les sorties (eau méditerranéenne "profonde" au niveau de Gibraltar). Des modifications dans le régime des apports continentaux (suite à l'accroissement de l'activité humaine) sont susceptibles, à plus ou moins long terme, d'avoir des répercussions dans les réserves nutritives du bassin méditerranéen. Les apports continentaux en phosphore ayant considérablement augmenté depuis 1960 (UNEP, 1988), BÉTHOUX et COPIN-MONTÉGUT (1988) et BÉTHOUX *et al.* (1992) ont proposé un modèle d'évolution temporelle des teneurs en phosphate des eaux profondes du bassin occidental. Selon leurs hypothèses, la concentration moyenne dans la couche 0-200 m qui était de 0.36 µM en 1960, a atteint 0.40 µM en 1980 et devrait être supérieure à 0.45 µM en 1995. Mais les nombreuses mesures que nous avons réalisées au cours des dix dernières années ne révèlent pas un tel changement. La figure 1 montre des distributions verticales typiques obtenues dans la partie centrale du bassin occidental (6°10E - 39°N) au cours des campagnes Mediprod IV (nov. 1981) et Mediprod VI (juin 1990). On observe une zone de gradient entre la surface et 400 m de profondeur. A partir de ce niveau la concentration atteint une valeur maximale (0.40 µM) qui se maintient jusqu'à 1000-1500 m. Au-delà de 1500 m la concentration diminue insensiblement pour atteindre 0.36 µM dans les eaux de fond. Les deux profils sont similaires, ne révélant pas l'existence d'une évolution notable des concentrations durant la dernière décennie dans cette région. Les concentrations mesurées aux différentes profondeurs sont parfaitement équivalentes à celles obtenues par GOSTAN (1968) à partir de l'ensemble des observations effectuées en mer Ligure au cours des années 1962-1963.

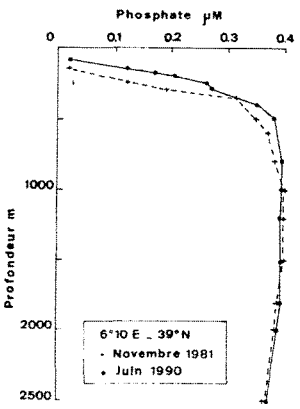


Fig. 1. Distribution verticale du phosphate au centre du bassin occidental en 1981 (Mediprod IV) et en 1990 (Mediprod VI)

Des teneurs supérieures à 0.40 µM ont été néanmoins mesurées au cours des campagnes Mediprod IV et VI, mais uniquement dans la partie Sud du bassin occidental, dans des régions marquées par une intense activité biologique : en mer d'Alboran (MINAS *et al.*, 1991) et au sein du courant algérien (RAIMBAULT *et al.*, 1993). Ces concentrations élevées en phosphate (jusqu'à 0.45 µM) sont localisées entre 200 et 400 m et sont associées à un minimum accentué d'oxygène (< 4 ml.l^{-1}). Ce maximum nutritif s'atténue aux stations éloignées des zones productives et disparaît dans les régions oligotrophes. Il est interprété comme le résultat de la décomposition de la matière organique produite en surface (MINAS *et al.*, 1991) et non comme la conséquence d'apports exogènes. A partir des constatations mettant en évidence la variabilité des teneurs en phosphate dans la couche 0-500 m et des particularités régionales dans la distribution du phosphate, nous proposons une nouvelle estimation de l'évolution temporelle de ces teneurs dans les eaux profondes. La figure 2 regroupe l'ensemble des données disponibles, mais d'où sont exclues les concentrations pour les profondeurs inférieures à 500 m ainsi que les valeurs obtenues localement au bas des zones productives et qui n'ont été échantillonnées qu'à partir des années 80. Ce schéma révèle que la concentration à 800-1000 m est stable depuis 1960 autour d'une valeur moyenne de 0.40 µM. les concentrations que nous avons mesurées en 1994 dans le golfe du Lion sont équivalentes à celles mesurées par GOSTAN (1968) en mer Ligure en 1963. Les données sont plus rares pour les eaux profondes (2500 m), mais aucune augmentation significative ne peut être décelée (la valeur moyenne est de l'ordre de 0.36 µM). Aucune concentration supérieure à 0.45 µM n'a été actuellement détectée dans les eaux profondes méditerranéennes contrairement aux prévisions de BÉTHOUX et COPIN-MONTÉGUT (1988). Il apparaît ainsi que les apports continentaux n'ont pas eu, encore à l'heure actuelle, d'influence notable sur les teneurs en phosphate en Méditerranée.

RÉFÉRENCES

BÉTHOUX J.P., COPIN-MONTÉGUT G., 1988. Phosphorus and nitrogen in the Mediterranean Sea: Specificities and forecasting. *In:* Océanographie pélagique méditerranéenne, H.J. Minas et P. Nival eds, *Oceanol. Acta*, N° Sp. 9: 75-78.

BÉTHOUX J.P., MORIN P., MADEC C., GENTILI B., 1992. Phosphorus and nitrogen behaviour in the Mediterranean Sea. *Deep-Sea Res.*, 39: 1641-1654.

GOSTAN J., 1968. Contribution à l'étude hydrologique du bassin Liguro-provençal entre la Riviera et la Corse. Thèse Doct. ès Sci., Université de Paris, 206 pp.

MINAS H.J., COSTE B., LE CORRE P., MINAS M., RAIMBAULT P., 1991. Biological and geochemical signatures associated with the water circulation through the strait of Gibraltar and in the western Alboran Sea. *J. geophys. Res.*, 96C: 8755-8771.

RAIMBAULT P., COSTE B., BOUHLADID M., BOUDJELLAL B., 1993. Origin of high phytoplankton concentration in deep chlorophyll maximum in a frontal region of the south-western Mediterranean Sea (Algerian current). *Deep-Sea Res.*, 40: 791-804.

UNEP, 1988. Le plan bleu, résumé et orientations pour l'action. Rac/blue plan: 1-94.

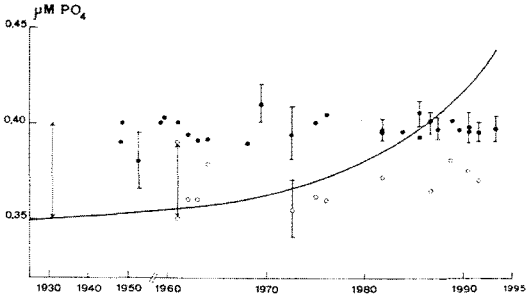


Fig. 2. Concentrations moyennes en phosphate dans les eaux profondes du bassin occidental d'après la littérature entre 800 et 1 000 m (●) et entre 2 000 et 2 500 m (○). la courbe régulière correspond à l'évolution prévues par BETHOUX et COPIN-MONTEGUT (1988).

UNCERTAINTIES IN FLUX ESTIMATIONS OF BIOGENIC GREENHOUSE GASES FROM THE WORLD'S OCEANS

S. RAPSOMANIKIS

Max Planck Institute for Chemistry, Biogeochemistry Department, P.O. Box 3060, 55020 Mainz, Germany

We determine the concentrations of N_2O, CH_4, OCS and $(CH_3)_2S$ (DMS) in surface waters of estuaries, shelf, shelf edge, open oceans using continuous equilibration techniques and automated gas chromatography (RAPSOMANIKIS *et al.*, 1994). Atmospheric concentrations of these gases are also determined in tandem. Horizontal profiles during cruise tracks have time resolution of up to one hour (in the worst case of OCS). Super- or under-saturation of surface sea waters for these gases is established, after computing equilibrium air-sea values using our high precision atmospheric concentration measurements and Henry law constants. The following basic equation for flux density calculations of the ith gas is used :

$$Fi = K_i * \Delta Ci \qquad (1)$$

where F_i= flux density, in units of concentration (mass/volume)/unit area/unit time

K_i= mass transfer coefficient in units of length/unit time

ΔC_i= concentration difference between the atmosphere and surface waters in units of concentration i.e. mass/ volume.

The concentration difference, ΔC_i, can be measured relatively accurately and precisely with modern instrumental, automated methods and the equilibrium calculations described above. In the case of DMS concentration of ocean surface waters exceed atmospheric concentrations by orders of magnitude, so that in flux density measurements one can ignore the later in calculating DCDMS. Large uncertainties persist on the parameterisation of the mass transfer coefficient K_i.

The simple case of DMS fluxes is treated here, using results from two cruises. The first cruise took place near the Antarctic peninsula between 10 December 1991 and 2 January 1992 (PFS Polarstern; Cruise ANT X/1b). The second cruise took place in the Eastern Mediterranean (Aegean, Levantine and Ionian Seas) between 2-18 July 1993 (RV Aegaio; Cruise "EGAMES"). Sea surface water samples were collected, filtered on line and analysed using a literature method (ANDREAE and BARNARD, 1983). In brief, a measured volume of water was purged with helium, the volatile DMS was trapped in a U tube filled with chromatographic packing and cooled to liquid nitrogen temperatures. Upon heating, DMS was separated from other volatile sulphur compounds, and detected in a sulphur selective FPD (flame photometric detector). Quantification was carried out using a series of liquid DMS standards in glycol, added to, DMS free, sea water. Surface sea water temperature, salinity, absolute wind speed and other meteorological parameters were continuously recorded from the ship's sensors. The DCDMS values obtained from the above cruises are treated using the K_i values obtained from equations obtained from experiments using: (a) SF_6 as a tracer in lakes (UPSTILL-GODDARD *et al.* 1990),(b) SF_6 and ^3He as dual tracers in stormy seas (Watson *et al.* 1991), which is based on the Liss and Merlivat model, (c) SF_6 and N_2O in a large wave generating wind tunnel (WANNINKHOF and BLIVEN 1991) and (d) an empirical approach for air-water gas exchange (GOSINK 1992).The two cruises present two contrasting environments for the calculation of flux densities of DMS. On one hand the productive and cold Antarctic waters with moderate to high wind velocities prevailing at the time of the cruise and on the other hand the Eastern Mediterranean marginal seas with high sea surface temperatures, low DMS concentrations and low wind velocities, are considered. Transfer coefficients calculated for the prevailing conditions at the time of sampling and using calculation methods (a) to (d) were used in equation(1) to determine flux densities for each cruise. Because of the uncertainties involved in each calculation method of these coefficients, the uncertainty of the flux densities calculations may also be within a factor of two. The values of the coefficients calculated by methods (a) to (d) fall within the uncertainty of each other. In a simple error propagation exercise, the overall uncertainty never exceeds 50%. At very high DMS concentrations and moderate wind velocities the flux densities are concentration dominated. At medium to high wind velocities and low DMS concentrations, there is no dominant factor for at least three of the models (Mediterranean cruise). It is hence obvious that there exists not a simple and single way of establishing the accuracy of these estimates across the wind velocity and concentration spectrum. It is also obvious that simple parameterisation of K_i against wind velocity, sea water temperature and diffusion coefficients, is not always possible. A number of other parameters like breaking waves and bubble formation may need determination and consideration in the calculation of K_i (WALLACE and WIRICK, 1992; FARMER *et al.*, 1993).An alternative, but not simple way, is to directly measure flux densities i.e. the F parameter in equation (1), using the "eddy correlation" technique. A stable platform, or corrections for the movement of the sampling platform (ship, buoy or floating platform) are necessary in this case. Also, corrections for flow distortions due to the shape of the sampling platform or the in-flow of air to the sampling lines, are necessary. A fast response, sensitive, detector is also required for the gas(es) that are going to be measured so that fluctuation in vertical flux densities can be resolved. If DCi can be calculated by determining the concentration of the ith gas in the surface sea waters, then K_i can be determined using again equation (1). Parameterisation of the K_i in these measurements will depend on the number of parameters measured at the time. The uncertainties in measuring flux densities and hence fluxes of green house gases from the world's oceans have been assessed by treating data for DMS flux densities from two contrasting oceanic areas. The possibility to measure transfer coefficients by the "eddy correlation" method is appealing but not simple.

REFERENCES

ANDREAE, M. O. and BARNARD W. R., 1983. Determination of trace quantities of dimethyl sulfide in aqueous solutions. *Anal. Chem.*, 55 : 608-612.

RAPSOMANIKIS S., GIMM H. and Andreae M.O. , 1994. Fluxes and oxidation products of dimethylsulfide in the Eastern Mediterranean Sea. *Mar. Chem.*, Submitted

FARMER D. M., MCNEIL C. L. and JOHNSON B. D., 1993. Evidence for the importance of bubbles in increasing air-sea gas flux. *Nature*, 361: 620-623.

GOSINK T. A., 1992. Air-water gas exchange. An empirical approach. *Sci. Tot. Environ.*, 112 : 221-231.

UPSTILL-GODDARD, R. C., WATSON A. J., LISS P. S. and LIDDICOAT M. I., 1990. Gas transfer velocities in lakes measured with SF6. *Tellus*, 42B : 364-377.

WALLACE D. W. R. and WIRICK C. D., 1992. Large air-sea gas fluxes associated with breaking waves. *Nature*. 356: 694-696.

WANNINKHOF R. H. and BLIVEN L. F., 1991. Relationship between gas exchange, wind speed and radar backscatter in a large wind-wave tank. *J. Geophys. Res.*, 96 : 2785-2796.

WATSON A. J., UPSTILL-GODDARD R. C. and LISS P. S., 1991. Air-sea gas exchange in rough and stormy seas measured by a dual-tracer technique. *Nature*, 349: 145-147.

DISTRIBUTION VERTICALE DES MÉTAUX EN MER D'ALBORAN : ENRICHISSEMENT EN MÉTAUX DES EAUX DE SURFACE (CAS DU CADMIUM)

R.D. RISO et P. LE CORRE

Lab. d'Océanographie chimique, Univ. de Bretagne, B.P. 809, 29285 Brest France

Les eaux de surface d'origine atlantique dans la mer d'Alboran (Méditerranée occidentale) présentent des teneurs élevées en métal. Les fortes concentrations ont été attribuées à des apports externes à la Méditerranée, provenant de l'Atlantique, ou à des apports côtiers dans la zone de Gibraltar (BOYLE *et al.*, 1985). L'observation des résultats disponibles montre que les teneurs en métaux augmentent en surface vers l'Est en Méditerranée (SPIVACK *et al.* 1973). Ceci nous a conduit à envisager la présence en Méditerranée d'une source interne en métal. Pour examiner cette hypothèse nous avons effectuées des mesures en mer d'Alboran lors de la campagne Almofront 1 (NO Atalante, avril - mai 1991). Les prélèvements ont été effectués à six stations sur une radiale Nord-Sud dans la zone du front géostrophique Almeria-Oran (fig. 1). Un échantillonnage serré a été effectué dans la couche de surface et de sub-surface (10 échantillons entre 0 et 500 m de profondeur). Les diagrammes T/S (0-500m) mettent en évidence dans ce secteur la présence de trois masses d'eaux : entre 0 et environ 75 m, l'eau atlantique de surface provenant de Gibraltar, à partir de 300 m l'eau levantine intermédiaire et entre ces deux masses d'eaux (de 75 à 300 m) l'eau méditerranéenne du Nord-Ouest. Cette eau qui est caractérisée par un minimum thermique (GASCARD et RICHEZ, 1985; PRIEUR *et al.*, 1992) est formée à l'intérieur du bassin méditerranéen, au voisinage des côtes françaises. La figure 2 montre la distribution verticale du cadmium (métal total dissous). Les concentrations en métal dans la colonne d'eau varient de 50 à 125 pM. Ces teneurs sont en accord avec celles présentées par BÉTHOUX *et al.*,)1990). Nos résultats indiquent la présence entre 75 et 300 m, dans la couche correspondant à l'eau méditerranéenne du Nord-Ouest, de fortes teneurs en métal. Les concentrations en cadmium des eaux de surface et sub-surface (0-300 m) varient de façon linéaire avec la salinité. Nous avons alors émis l'hypothèse (RISO *et al.*, 1994) que la masse d'eau du minimum thermique pouvait contribuer de façon notable à l'enrichissement en métal des eaux de surface. Sur la base des mesures d'adsorption de l'azote (15N-nitrate; L'Helguen com. pers.) les coefficients de diffusion verticaux ont été calculés; ils montrent que les flux verticaux, en raison de la présence du jet d'eau atlantique, sont accentués. Les calculs indiquent que dans le secteur du front les apports profonds seraient d'un ordre de grandeur supérieur aux apports atmosphériques. Les transports verticaux expliquent, du moins pour partie, l'enrichissement en métal des eaux atlantiques en mer d'Alboran.

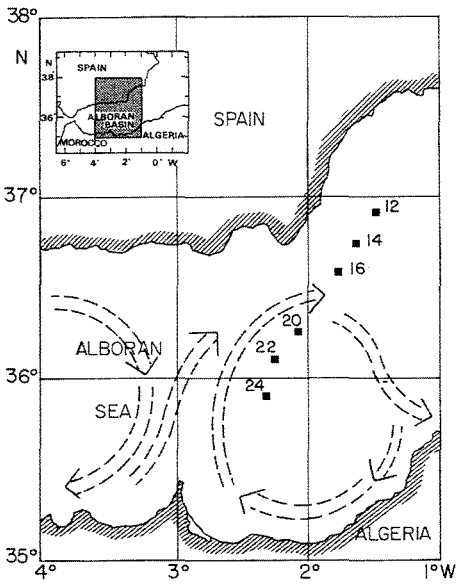


Fig.1 a) Emplacement des stations en mer d'Alboran (■)
b)===⇒Tracé schématique du front Géostrophique.

RÉFÉRENCES

BÉTHOUX J.P., COURAU O., NICOLAS E. et RUIZ-PINO D. 1990. Trace metal pollution in the Mediterranean Sea. *Oceanol. Acta*, 13(4): 481-488.

BOYLE E.A., CHAPNICK S.D., BAI X.X. et SPIVACK A. 1985. Trace metal enrichment in the Mediterranean Sea. *Earth Planet. Sci. Lett.*, 74: 405-419.

GASCARD J.C. et RICHEZ C. 1985. Water masses and circulation in the Western Alboran Sea and in Straits of Gibraltar. *Prog. Oceanogr.*, 15: 157-216.

PRIEUR L., MORIN P., MINAS M., SOURNIA A. et MINAS J.H. 1992. Circulation à méso-échelle et masses d'eau en mer d'Alboran est. Processes and budgets in geostrophic fronts. *JGofs-France Rep.*, 13: 84-86.

RISO R.D., LE CORRE P., MORIN P. et CABON J. Y. 1994. Vertical distribution of cadmium, copper and lead in the eastern Aboran Sea: enrichment of metals in surface waters. *J. Mar. Syst.* 5: 391-399.

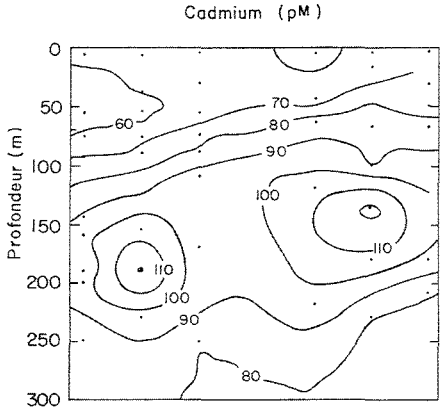


Fig.2 Distribution vertical du Cd (pM) en mer d'Alboran (Radiale A - Almofront-1)

MARINE SPECIMEN BANKING. A MEDITERRANEAN PERSPECTIVE

M. ROSSBACH[1], G. KNIEWALD[1,2]

[1] Institute of Applied Physical Chemistry, Research Centre Juelich (KFA), 5170 Juelich, Germany

[2] Center for Marine Research Zagreb, Ruder Boskovic Institute, 41000 Zagreb, Croatia

Specimen banking for biological and human tissue has been well established for about two decades (ROSSBACH *et al.*, 1992). Environmental samples archived as part of monitoring programs have been found useful in a number of specific studies (WISE and ZIESLER, 1984).

The world ocean - being the final sink for many natural and anthropogenic substances (BRANICA and KNIEWALD, 1991), - is a "labile" ecosystem which is and has for a long time been the focal point of extensive interdisciplinary research. Measurements of heavy metals and a suite of various chemical compounds in the marine environment has mostly been carried out on limited scales, within national (or regional at best) monitoring programs (i.e. the Mussel Watch program in the USA, or the North Sea or Baltic survey by the Northern European countries). Most of these actions were restricted to coastal waters and estuaries which are more severely impacted by pollution than the open ocean. A long term systematic investigation of human impact on the oceans of the world (along the global currents, the Gulf stream or El Nino and verging on the main shipping trails) would ideally require a central survey station accompanied by an extensive banking facility, capable of handling a large volume of various marine samples.

As in the past, analytical performance will certainly continue to improve with respect to accuracy and sensitivity. The general awareness and public concern about important environmental factors has been permanently increasing over the last decade. Unless original materials from the past will be available in due time, neither trend-evaluation nor forecasting will be possible on sound scientific reasoning.

The storage of all kind of marine specimen (from water to sediment, fish and algae, plankton, etc.) on a global scale is necessary to provide future investigators with authentic materials which will facilitate an assessment and sources of environmental stress on various marine ecosystems.

Natural "banks" of specimens such as deep sea sediments or the ice sheets of the poles are very difficult to probe if trace elements or other micro-contaminants are considered. Stringent sampling procedures have to be developed and only specialized teams can assure that the quality standard of every sampling campaign is maintained. It is clear to day that the accuracy of an analytical result in the first place is a direct function of the sampling procedure. Data interpretation should therefore always start with a critical discussion of the various steps of the sampling procedure (ROSSBACH and KNIEWALD, 1993).

Transportation and intermediate storage requires special attention so that valuable material is not wasted by careless treatment. Contamination and losses are appropriately avoided if a centralized storage facility - with well trained personell - takes ultimate care to maintain full integrity of the materials over prolonged periods of time.

The state-of-the-art technology is permanent storage under liquid nitrogen vapor (-140°C) in glass or plastic containers. Large cryo-vessels of more than 1000 L capacity are available and maintenance can be automated.

The aim of such a long term, large scale banking programme is not the discovery of new compounds or unknown species but to provide future generations of researchers with authentic material of the past. A general oceanographic specimen bank is technically achievable and the value of such a sample repertoire will be shown soon after its instigation.

Regional marine specimen banks could serve as models for an appropriate sample storage facility (SSF) on a large (global) scale, and would serve the purpose of gathering requisite experience on various logistic aspects of such a project - ranging from site-location, accessibility to transportation routes and infrastructure, training of staff, operations etc. It is envisaged that a feasibilty study for a regional Adriatic and/or Mediterranean marine specimen bank located on the Croatian Adriatic coast will be undertaken in due course.

The needs and prospects for a marine specimen bank are clearly evident. If the various aspects of marine research are well poised for the 21st century, a storage facility with samples from the past will strengthen its position in the concert of natural sciences aimed at a better understanding and prediction of environmental processes. Climatic changes - today a topic of prime concern - will only be an episode if one day the environmental collapse of the oceans should be encountered. To prevent such catastrophes, early trend monitoring and careful assessments should be started on the basis of long term observations.

ACKNOWLEDGEMENTS.

MR acknowledges the financial support by the Bundesminister für Umwelt, Reaktorsicherheit und Naturschutz, Bonn, and the Umweltbundesamt, Berlin. Part of this study was facilitated through a research grant to GK by the Alexander von Humboldt foundation, Bonn.

REFERENCES

BRANICA, M. and G. KNIEWALD (eds.). 1991. Reactivity of chemical species in aquatic environments. *Marine Chemistry*, 1-4 : 1-386.

ROSSBACH, M., J.D. SCHLADOT and P. OSTAPCZUK (eds.). 1992. Specimen Banking - Environmental Monitoring and Modern Analytical Approaches. Springer Verlag, Heidelberg.

ROSSBACH, M. and G. KNIEWALD; Marine Specimen Banking. International Symposium "Futures in Marine Chemistry", May 1993, Brijuni Is., Croatia.

WISE, S.A. and R. ZEISLER. 1984. The pilot Environmental Specimen Bank program. *Environmental Science and Technology*, 18 : 302A-307A.

GRADIENT VERTICAL DES SELS NUTRITIFS EN MILIEU CÔTIER DANS LA RÉGION D'ALGER

F. L. SAMSON-KECHACHA et R. DAHMANI

Lab. de biologie et d'écologie marines, ISN-USTHB, 16011 Bab Ezzouar, Algérie

Dans les milieux côtiers, estuariens ou lagunaires, très étudiés pour leurs capacités à accueillir des élevages aquacoles, les bilans de matières nutritives s'établissent en tenant compte à la fois des apports par le littoral tout proche et aussi des apports par le fond après reminéralisation de la matière organique constituée par les biodépôts. En Algérie, l'activité aquacole est encore balbutiante mais elle représente une motivation pour l'étude des espèces aquacoles et des milieux infralittoraux et lagunaires. Dans la région d'Alger, certains sites abritant des populations naturelles de mollusques bibalves font l'objet de travaux (BOUBEZARI, 1992; SAMSON-KECHACHA *et al.*, 1992). Afin d'avoir une idée sur le sens des flux de sels nutritifs et les contributions respectives du sédiment et des eaux continentales à l'enrichissement des eaux côtières en matières minérales, nous nous sommes intéressés à la distribution verticale des sels d'azote et du phospore dans l'eau et le sédiment dans trois sites de la région d'Alger : près d'Alger Plage (station 1) et de Tamestefouet (station 2) dans l'est de la baie d'Alger, près de Bouserdès à environ 20 km d'Alger plage, vers l'Est (station 3). Les trois sites diffèrent par les conditions hydrodynamiques locales, par la qualité géochimique du sédiment (ABBADA-GUERROUI *et al.*, 1994) et par les peuplements naturels de mollusques bivalves qui les colonisent. Les prélèvements sont réalisés dans l'isobathe - 3 m. Des carottes en plexiglas de 3,5 cm x 20 cm sont enfoncées dans le sédiment par un plongeur, la base est dégagée et la carotte bouchée aux deux extrémités. A la remontée, l'eau de demi-fond (1,5 m sous la surface) est prélevée dans un flacon par le plongeur. L'eau de fond est récupérée par aspiration, à l'aide d'une pipette, dans le surnageant de la carotte et l'eau interstitielle par centrifugation du sédiment à 4 000 R.p.m pendant 25 minutes et à 0,4°C. Les dosages sont réalisées par des méthodes classiques (AMINOT et CHAUSSEPIED, 1983).

Azote nitrique et nitreux. Les concentrations de ces deux sels sont très faibles : 0,2 à 0,5 µM/l et les flux négligeables. Ce fait a été signalé par GRENZ *et al.* (1992) et par BAUDINET (1990) qui note une absorption de nitrate par les sédiments.

Ammonium. Les teneurs en ammonium sont très élevés sur les profils des trois stations. Le gradient est très élevé (fig. 1) et suggère un approvisionnement de la colonne d'eau en $NH4^+$ à partir du sédiment. Ces flux positifs d'azote ammoniacal ont été décrits dans des zones mytilicoles par BAUDINET *et al.* (1990) et GRENZ *et al.* (1992).

Phosphore inorganique. A 1,50 m sous la surface, les teneurs en phosphore sont déjà très élevés : 3,9 à 9,5 µM/l (fig. 2). Des concentrations importantes sont retrouvées en surface aux stations 2 et 3 (METAP, 1994). Autrement dit, même en surface, le phytoplancton n'arrive pas à épuiser le phosphore qui provient probablement des effluents urbains. A cet approvisionnement externe vient s'ajouter le relargage par le sédiment, particulièrement net à la station 3 où le profil surface-fond des phosphates est comparable à celui de l'ammonium. Les flux inverses de phosphate aux stations 1 et 3 s'expliquent par les conditions spécifiques de chacune de ces stations. La station 1 est à l'embouchure de l'oued El Hamiz qui draine les zones agricoles et industrielles et reçoit des substances phosphorées. A la station 3 par contre, la richesse exceptionnelle du sédiment en phosphate s'explique par la présence d'une moulière naturelle qui transfère le phosphore contenu dans la matière organique des fèces et pseudofèces vers le sédiment et, après reminéralisation, crée un flux positif de phosphates (BAUDINET, 1991). L'examen du rapport N/P montre que celui-ci augmente en allant de la surface vers le fond. Ceci confirme que la part du relargage par le sédiment dans l'approvisionnement en phosphore est moins importante que celle des apports continentaux. Cette différence entre surface et fond dans la valeur du rapport N/P est plus marquée aux stations 1 et 2 sous l'influence des rejets d'El Hamiz, qu'à la station 3 plus ouverte au large. Il semble donc que dans la région étudiée, l'écosystème pélagique bénéficie d'un flux en phosphore qui transite par l'interface continent-océan et d'un flux en azote provenant du sédiment.

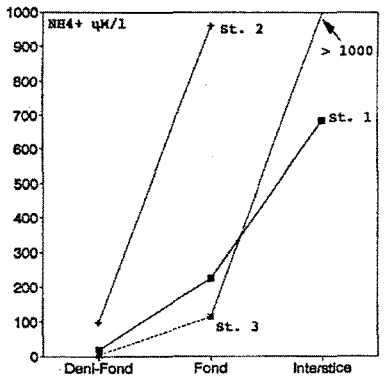


Figure 1 : Profil de l'azote ammoniacal aux trois stations

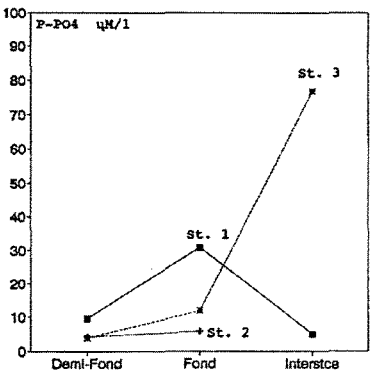


Fig. 2. Profil des phosphates aux 3 stations

RÉFÉRENCES

ABADA-GUERROUI H., SAMSON-KECHACHA F.L., DAHMANI R., 1994. Accumulation de matières organique et minérale dans la zone infralittorale de la région Est de la baie d'Alger. Colloque international "Eau et pollution", Agadir, Maroc.

AMINOT A., CHAUSSEPIED M, 1983. Manuel des analyses chimiques en milieu marin. CNEXO, Brest, pp. 107-142.

BAUDINET D., ALLIOT E., BERLAND B., GRENZ G., PLANTE-CUNY M.R., PLANTE R., SALEN-PICARD C., 1990. Incidence of mussel culture on biogeochemical fluxes at the sediment-water interface. *Hydrobiologia*, 207 : 187-196.

BAUDINET D., 1991. Flux nutritifs particulaires et dissous dans un écosystème mytilicole côtier méditerranéen. Thèse doct. en Océanologie. Aix-Marseille II.

BOUBEZARI K., 1992. Contribution à l'étude des peuplements de trois moulières naturelles dans la région d'Alger. Thèse magister en océanologie, USTHB, Alger.

GRENZ G., ALLIOT E., BAUDINET D., HELLIS L., MASSE H., 1992. Influence des opérations de dévasage sur les flux de nutriments à l'interface eau-sédiment (bassin de Thau, France). *Vie Milieu*, 42 (2) 157-167.

METAP, 1994. Etude de protection contre la pollution des ports et du littoral algériens. Min. Transports, Alger.

SAMSON-KECHACHA F.L., HELLAL O., HELLIS L., 1992. Caractéristiques phytoplanctoniques de deux stations côtières de l'Est algérois. *Hydroécologie appliquée*, 4 (2) 1123-138.

HEAVY METAL SPECIATION IN COASTAL SEDIMENTS NEAR AN INDUSTRIAL AREA (SARDINIA, ITALY).

SCHINTU M.[1], CONTU A.[1], DIANA D.[1], MELONI P.[1], DEGETTO S.[2]

[1] Dipartimento Igiene e Sanità Pubblica, Università di Cagliari, Via Porcell 4, 09100 Cagliari, Italy

[2] ICTIMA -CNR. A.d.R., C.so Stati Uniti 4, 35100 Padova , Italy

The industrial area of Portovesme, in the south-western coast of Sardinia (Italy) has been mainly based on aluminium production, lead-zinc smelting and coal-fired power generation, since the early 1970's. The area is located in a mineralised region (mainly lead and zinc deposits) with past and present mining activity. Although a substantial direct atmospheric fallout of metals was identified as the main source of land pollution around the industrial area (CONTU *et al.*, 1986; D.P.R. 23/4/1993), there are several other possible mechanisms of contamination of the marine environment in the surrounding area :

1) the direct discharge of liquid effluents from a smelter and a coal-fired power plant into the harbour at Portovesme

2) continuous losses of coal, ores or concentrates during loading/unloading of ships and handling

3) the run-off from mining and smelting areas.

To investigate the heavy metal content of the sediments, cores up to about 40 cm were collected from 4 sampling stations in the harbour of Portovesme in January 1993. Samples were taken by scuba divers using Plexiglas liners with a diameter of 6 cm. Sediment cores were immediately frozen and cut into 2 cm layers in the laboratory. Radiochronological and chemical analyses were carried out. The depth distribution of the activity of Pb-210 and Cs-137 revealed different sediment accumulation rates in the sampling stations in the harbour and procured the pollution history of the area up to beginning of this century. Details of these procedure have been given elsewhere (DEGETTO *et al.*, 1993).

In an attempt to determine the distribution of Pb, Zn, Cd and Hg among the major sediment components and to assess a possible remobilisation of contaminants, metals were extracted from wet samples by a series of reagents of increasing reactivity :

1) CH_3COONH_4 1 M (at a solid/solution ratio of 1/20) at pH 7.0 in centrifuge tubes for 2 h, at room temperature.

2) HCl 0,5 N (24 h at room temperature).

3) HNO_3-$HClO_4$ (4:1) acid mixture. Samples were digested for 4 h at 90°C in Sovirel bottles with screw caps.

4) an acid mixture of HF-HNO_3-$HClO_4$ (total attack) in Teflon lined acid bombs.

Lead, Zn, Cd, and Hg were measured by atomic absorption spectrometry with background correction using the standard addition method. Mercury was determined with the cold vapour method. Grain size distribution, Al, and organic substances were also determined.

Metal accumulation in the sediments proved to be strongly affected both by the grain-size and by the presence of extremely high concentrations of Al of anthropogenic origin in the upper layers of the cores. Very high total concentration of Cd, Hg, Pb and Zn were measured in the upper layers of all cores in the sediment accumulated after the industrial development of the area (1965). The highest metal concentration (Hg 109 mg/kg d.w.; Cd 118 mg/kg d.w.; Pb 2520 mg/kg; Zn 13400 mg/kg d.w.) as well as the highest fluxes of the metal (mg/m^2/year) were found near the liquid effluent outlet of the plants, where a point source of contamination were detected. The level of all metals were increased substantially above background. Metal enrichment factors defined as the ratio between the average of the metal concentration in the layers deposited after 1965 and the lowest layer, ranged from 4 to 7 for Hg and from 4 to 6 for Cd. However background values are quite high, considering the geochemical characteristics of the area.

Percentages of Cd ranging from 51 to 89% of the total metal were extracted with HCl 0.5 N from the superficial layer (0-2 cm) of the cores, while in the lowest layers these percentages ranged from 14 to 26%. A similar pattern was found for Pb and Zn while lower percentages of the total were extracted. Mercury was recovered with both HCl 0.5 M and CH_3COONH_4 1M only from the superficial layers of the cores, in percentages ranging from 2.5 to 11.5% of the total Hg for the dilute HCl attack, and from 1.5 to 5% with the CH_3COONH_4 1M. In general the greatest differences between upper and lower section for the metal extraction with both CH_3COONH_4 1M and dilute HCl were found in the area most exposed to the industrial waste effluent.

The results suggest that most of Cd, Hg, Pb, and Zn accumulated in the sediments after the settlement of the industries are of anthropogenic origin and in exchangeable or adsorbed forms. Several authors (LUOMA, 1983; BRYAN, 1984; CAMPBELL *et al.*, 1988, KERSTNER and FORSNER, 1990) considered the metals extracted by HCl 0.5 M or CH_3COONH_4 as a measure of their bioavailability. These results point out the risk of remobilisation of high quantities of toxic metals from the sediments in the harbour.

REFERENCES

BRYAN, W., 1984. "Pollution due to heavy metals and their compounds". *In:* Marine Ecology, John Wiley & Sons, 1289-1431.

CAMPBELL, P.G.C. and TESSIER, A., 1989. 'Biological availability of metals in sediments: analytical approaches', Heavy Metals in the Environment, 7th International Conference, Vol. 5, pp. 516-525.

CONTU A., FLORE C, SCHINTU M., SPIGA G., 1986. Piombo e cadmio nel suolo e nei vegetali di un'area industrializzata della Sardegna. Inquinamento, XXVIII, 3, 2-6.

DEGETTO S., SBRIGNADELLO G., SCHINTU M., 1993. Stratigraphic radiochemical analysis of short-core sediments from Portovesme (Sardinia) as a record of environmental pollution. Atti XXII Congresso Nazionale di Chimica Inorganica, Villasimius (Cagliari), Settembre 1993, p. 85.

D.P.R. 23/4/93. Piano di disinquinamento per il risanamento del territorio del Sulcis-Iglesiente. Gazzetta Ufficiale della Repubblica Italiana, 14/8/93.

KERSTNER M. and FORSTNER U., 1990. Speciation of trace metals in sediments. In "Trace metal speciation: analytical methods and problems", G. E. Batley Ed., CRC Press.

LUOMA S. N., 1983. Bioavailability of trace metals to aquatic organisms- A review, *The Science of Total Environment*, 28, 1-22.

IODINE SPECIATION IN THE WATER COLUMN OF THE ROGOZNICA LAKE (EASTERN ADRIATIC COAST)

V. STIPANICEV and M. BRANICA

Center for Marine Research, Ruder Boskovic Institute, Zagreb, Croatia

Iodine occurs in sea water predominantly as iodate and iodide, although some quantities of organic iodine may also be present. Total iodine concentration in sea water is approximately 500 nM. The calculated concentation ratio of iodate to iodide under redox equilibrium conditions (pH = 8.1, p_{O2} = 0.21) is $10^{13.5}$, and it is assumed to be controlled by O_2/H_2O couple which strongly favoures iodate. Measurable concentrations of iodide and nutrient-like behavior of iodine suggest that biological and photochemical processes may promote a reduced form of iodine (LUTHER and WU, 1992).

Due to redox sensitive and biophillic nature of iodine it is of special interest to study the distribution of iodide, iodate and organically bound iodine in the water column of a basin where both oxic and anoxic conditions occur (LUTHER and CAMPBELL, 1991; LUTHER *et al.*, 1991). Such conditions have been found in the Rogoznica lake (Dragon's eye). It is a small, salt lake, surrounded with vertical carbonate rocks. The existance of mediolittoral zone suggest the connection between the lake and nearby sea. Due to oxygen content the water column of the lake can be devided into the upper oxic and the lower anoxic zone, during the stratification period (April-October).

To ascertain the depth and seasonal variations in speciation of iodine, samples were colected in September and November 1993, and April 1994. Temperature, salinity and oxygen content were determined immediately after collection. Iodide has been determined directly in water samples by cathodic stripping sqare wave voltammetry. Differential pulse voltammetry has been used to determine iodate, total iodine (by hypoclorite oxidation of the lake water sample to iodate) and indirectly organo-iodine (by UV irradiation followed by hypoclorite treatment).

	September, 1993			November, 1993			April, 1994		
Depth	O_2/mgl^{-1}	S/‰	t/oC	O_2/mgl^{-1}	S/‰	t/°C	O_2/mgl^{-1}	S/‰	t/°C
0.5	6.62	33	23.9	7.97	37	17.8	8.95	27	15
2.0	6.63	36	23.1	8.46	37	17.6	8.48	27	15
5.0	5.36	36.5	22.9	4.89	39	19.2	7.69	35.5	17
7.0	4.46	37	22.9	4.62	40	19.5	4.12	38	19
8.0	4.38	38	22.9	4.46	39	19.5	2.96	38	19
8.5	4.32	38	22.9	4.09	40	19.5	3.93	39	19
9.	4.22	38	22.7	4.19	40	19.5	1.09	39	19
9.5	3.77	38	22.7	3.99	40	19.5	0.07	39	19
10.0	2.71	38	22.6	3.62	40	19.5	0.09	39	19
10.5	3.74	38	22.6	3.73	39.5	19.5	ND	39	19
11.0	2.52	38	22.5	3.02	38	19.5	ND	39.5	18
12.0	ND	38	22.5	1.45	40	19.5	ND	39.5	18

Table 1. Salinity, temperature and oxygen content from the Rogoznica Lake, September and November 1993. and April 1994.

The depth of the oxic-anoxic interface varies upon the season and strongly affects the vertical distribution of iodine species. Iodate concentrations in the upper layers are similar to those observed in sea water. Only reduced forms of iodine are found to be present in the bottom layers. The difference between the total iodine and the sum of iodide and iodate was significant in April and can be attributed to organic compounds which can react with hypochlorite. No difference was found in November The contribution of other organo-iodine species (determined as species decomposed by UV-irradiation) was also the lowest in November, and can be connected with negligible biological activity during this period of year.

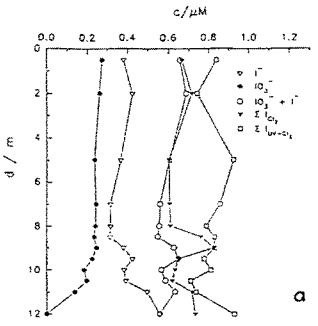
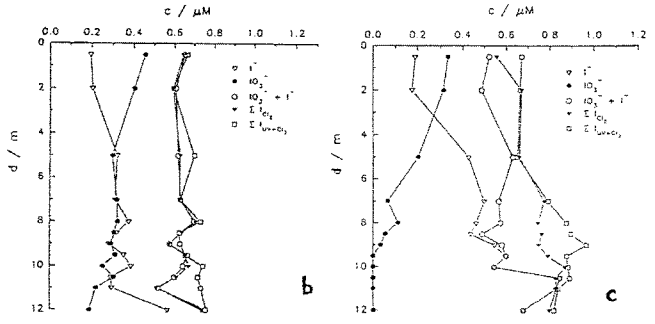


Figure 1. Vertical distribution of iodine species in the Rogoznica Lake a) September 1993. b) November 1993. c) April 1994.



REFERENCES

G.W. LUTHER and J. WU. 1992. Redox chemistry of iodine in seawater reviseted frontier molecular orbital theory considerations. *Journal of American Chemical Society*, 32(1) : 642-652.

G.W. LUTHER and T. CAMPBELL. 1991. Iodine speciation in the water column of the Black Sea. *Deep-Sea Research*, 38(2) : S875-S882.

G.W. LUTHER *et al.* 1991. Iodine Chemistry in the Water Column of the Chesapeake Bay: Evidence of Organic Iodine Species. *Estuarine, Coastal and Shelf Science*, 32 :267-279.

DISTRIBUTION OF CD, PB, CU AND ZN IN CARBONATE SEDIMENTS FROM THE KRKA RIVER ESTUARY, CROATIA

Budimir SURIJA and Marko BRANICA

Center for Marine Research, Ruder Boskovic Institute, Zagreb, Croatia

We studied distribution of trace metals (Cd, Pb, Cu and Zn) as well as some sediment components (carbonates, organic matter i.e. loss on ignition - LOI, Fe and Mn) in oxic carbonate sediments from the Krka estuary. By applied chemical extraction technique (somewhat modified procedure of TESSIER *et al.*, 1979), it is possible to distinguish : exchangeable cations (F1), carbonates (F2), hydrous oxides of Fe and Mn (F3), organic matter (F4) and residual (F5). Although carbonates are regarded rather as trace metal diluters in sediments than as their collectors, selective chemical extraction procedures are mainly designated to differentiate also the carbonate fraction between other fractions (KERSTEN AND FÖRSTNER, 1990). High metal concen-tration in this fraction is often regarded as a pollution indicator, i.e. that fraction represent metals desorbed from other substrates (like Fe and Mn hydrous oxides and organic matter). This indeed seems to be the case for polluted estuaries with prevailing non-carbonate sediments. The Krka river estuary is a non-polluted estuary with low total metal input and very low sedimentation rates (average 0.12 mm/y in the upper part, negligible in the seaward part of the estuary, PROHIC and JURACIC, 1989). Previous study of the carbonate sediments from the Krka estuary, by PROHIC and KNIEWALD (1987), showed the high percentage of some trace metals (Mn, Cu, Pb and Zn) in this fraction, despite the low metal levels in the majority of analyzed samples. Procedure was performed on grain size fractions: 300-150 , 150-61 and 61-5 µm. Trace metals were determined by differential pulse anodic stripping voltametry (DPASV). Trace metal concentrations were found as Cd 0.156-0.399, Pb 17.3-118.6, Cu 19.1-52.1 and Zn 66.2-168.1 µg/g dry wt., in the smallest size fraction, along the estuary (sampling sites shown in Fig. 1). Distribution of trace metals differed for different size fractions. Generally, there was no relation between metals concentrations in fractions F2, F3 and F4 and the concentrations of sediment components (CaCO3, organic matter, Fe and Mn. Seaward, total trace metal concentrations and carbonates increased while organic matter and Fe decreased (also did Mn, being highest at site E-4). The highest metal concentrations were obtained in F2 (Pb in 61-5 µm and Cd and Zn in 300-150 µm size fraction) and in F3 (Cu, Zn and Cd in 61-5 µm). The concentrations in other fractions were low (Fig. 2). It seems that carbonates can not be regarded exclusivly as a trace metal diluter in the actual carbonate sediments present in the Krka river estuary.

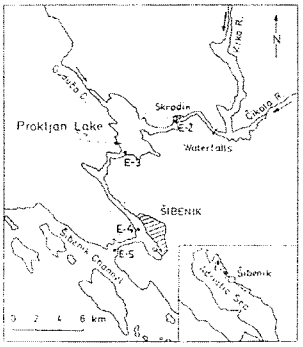


Fig. 1. The study area with the sampling sites

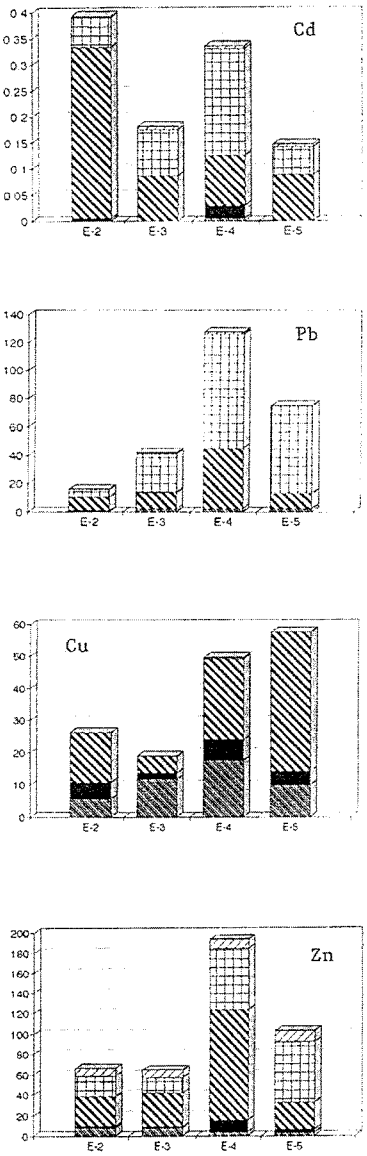


Fig. 2.. Concentrations, at four sampling sites, of trace metals (Cd, Pb, Cu and Zn) in chemical fractions of sediments for grain size fractions 61-5 µm (µg/g dry wt.).

F1
F2
F3
F4
F5

REFERENCES

KERSTEN M. and U. FÖRSTNER, 1990, Speciation of trace elements in sediments, in Trace Element Speciation: Analytical Methods and Problems, G.E. Batley (ed.), CRC Press, Boca Raton, pp. 246-309.

PROHIC E. and G. KNIEWALD, 1987, Heavy metal distribution in recent sediments of the Krka River Estuary - an example of sequential extraction analysis. *Mar. Chem.*, 22 : 279-297.

PROHIC E. and M. JURACIC, 1989, Heavy metals in sediments. Problems concerning determination of the anthropogenic influence. Study in the Krka river estuary (Eastern Adriatic Coast, Yugoslavia). *Environ. Geol. Water Sci.*, 13 : 125-131.

TESSIER A., P. CAMPBELL and M. BISSON, 1979, Sequential extraction procedure for the speciation of particulate trace metals, *Anal. Chem.* 51 : 844-851.

DISTRIBUTION OF PHOTOSYNTHETIC PIGMENTS IN THE PLUME OF THE RHONE RIVER

Senka TERZIC[1], Marijan AHEL[1], Jean-Jacques NAUDIN[2] & Gustave CAUWET[2]

[1] Center for Marine Research Zagreb, Ruder Boskovic Institute, Zagreb, Croatia

[2] Group. de Recherches "Interactions Continent-Ocean", Lab. Arago, Banyuls s/Mer, France

Chlorophyll and carotenoid pigments are useful biomarker compounds for studying various biological processes in the marine environment. They proved to be especially helpful for providing additional information about the chemotaxonomic composition of phytoplankton as well as about formation and degradation of the phytoplankton biomass (BARLOW *et al.*, 1993). However, as opposed to a number of reports on phytoplankton dynamics in oceans by using pigments as biomarkers there seem to have been only limited number of such studies in estuarine, coastal and shelf areas (DENANT *et al.*, 1991). In such areas, additional nutrient inputs by rivers were shown to have a strong impact on phytoplankton dynamics resulting often in an enhanced standing stock of phytobiomass. The aim of this paper is to investigate the build-up of the phytoplankton biomass in the freshwater plume of the Rhone River (France). Chloro-phyll and carotenoid pigments were deter-mined according to a modified HPLC method by Mantoura and Llewellyn (BARLOW *et al.*, 1993). Briefly, water samples (2 L) were filtered through 47 mm Whatman GF/F filters and immediately frozen until analysed. Frozen filters were extracted in 4 mL 90% acetone and analysed using a gradient reversed-phase HPLC system equipped with both spectrophotometric and spectrofluorimetric detectors and dual channel data collection and integration. Chlorophylls and carotenoids were detected by absorbance at 440 nm while detection of phaeopigments was performed with a fluorescence detector using an excitation wavelength of 420 nm and emission at 672 nm. Sampling was performed in the framework of a Lagrangian experiment, aiming at studying the development of organic matter in the Rhone estuary, between 11th and 21st November 1993 (Fig. 1). Water samples for pigment analyses were collected at four different depths in the top 10 m of the water column. The experiment was undertaken on four different days, between 8^{00} a.m and 17^{00} p.m. in exact time intervals of 60-120 minutes (stations A-F). Concentrations of photosynthetic pigments in the Rhone estuary during the experiment showed a strong spatial and temporal variability (790-10800 ng/l of Chl *a*). Signatures of phytoplankton composition indicated that diatoms were the most abundant class as reflected by a pronounced predominance of fucoxanthin (fuc) over other accessory pigments (Fig. 2). Low concentrations of 19'-hexanoyloxy-fucoxanthin (hex) and chlorophyll b (Chl *b*) detected in the samples suggested a rather low contribution of Prymnesiophytes and green algae to the total phytobiomass. Moreover, comparatively low concentrations of phaeophorbides and phaeophytins (< 250 ng/l) were indicative of the freshly formed phytoplankton biomass, still mainly unaltered by grazing or other degradation processes. Distribution of photosynthetic pigments on vertical profiles in the freshwater plume of the Rhone estuary (Fig. 2) revealed a very dynamic behaviour of the phytobiomass as a consequence of the strong response to the input of riverborne nutrients, in particular nitrate. However, the concentration maxima of photosynthetic pigments were not observed at the surface, characterised by the lowest salinities and consequently the highest nitrate concentrations, but in the subsurface layer (1.5-3 m) characterised by salinities between 30-35‰ and much lower nitrate levels. This suggested that phytoplankton biomass was predominately of marine origin. Thus, the salinity range below 25‰ was probably the limiting factor which precluded a stronger build-up of marine diatoms in the uppermost layer. The diatom peaks observed on the vertical profiles can be interpreted as a compromise between the nutrient supply from the top of the water column and salinity tolerance of marine phytoplankton. The profiles similar to those presented in Fig. 2 were observed only during relatively calm weather conditions which allow the system to maintain stratification over the time periods required for a build-up of the phytobiomass.

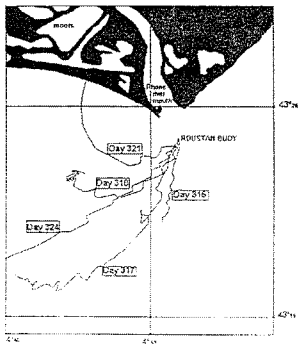


Fig. 1. Map of the Rhone estuary with indicated trajectories followed during sampling on 5 different days.

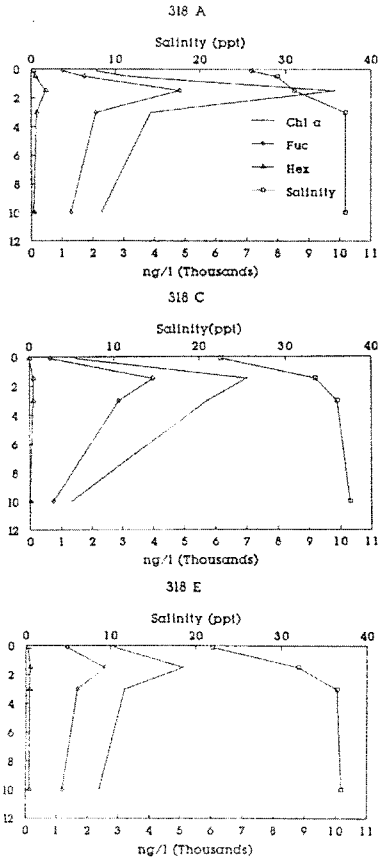


Fig. 2. Vertical profiles of chl *a* and two accessory pigments in the Rhone estuary (Day 318 see Fig. 1)

REFERENCES

BARLOW R.G., MANTOURA R.F.C., GOUGH M.A. and FILEMAN T.W., 1993. Pigment signatures of the phytoplankton composition in the northeastern Atlantic during the spring 1990 diatom bloom. *Deep-Sea Res.* II, 40 : 459-477.

DENANT V., SALIOT A. and MANTOURA R.F.C., 1991. Distribution of algal chlorophyll nad carotenoid pigments in a stratified estuary: the Krka River, Adriatic Sea. *Mar. Chem.*, 32 : 285-297.

GRANULOMETRIC AND ORGANIC MATTER DEPENDENCE OF PB AND CD ACCUMULATION IN SEDIMENTS FROM THE KASTELA BAY (SPLIT, CROATIA)

Ivana UJEVIC[1], Niksa ODSAK[2], Ante BARIC[2]

[1] Faculty of Natural Sciences and Arts, University of Split, Croatia
[2] Institute of Oceanography and Fisheries, Split, Croatia

As investigation on trace metals in sediments are part and environmental of pollution control, the comparability of the results obtained is an indispensable prerequisite for trace metals monitoring. Therefore, trace metal concentrations have been determined in separate fraction (BROOK *et al.*,1988, MARTINCIC *et al.*, 1990, SCHNEIDER *et al.*, 1984) and in whole sediment and correlated with percentage of fine grained fraction (DONAZZOLO *et al.*, 1981). Sediment samples were collected at six stations in the Kastela Bay. The cores were divided into subsamples (5 cm long), and the subsamples were fractionated by wet sieving technique. The following sediment fractions were analyzed : 20–54 µm and <20 µm. Organic matter and trace metals (Pb and Cd) concentrations are determined in these fractions, as well as in the unsieved sediment samples. Electrothermal atomic absorption spectrometry was used for Pb and Cd concentrations. Linear regression method was applied for statistical purposes. The distribution of Pb in analyzed fractions of sediment show that it is significantly associated with smaller size particles, whereas Cd does not show such distribution (Fig. 1).

a)	Pb	Cd	b)	Pb	Cd
r	0.605	0.115		0.445	0.246
P	0.006	0.785		0.057	0.692
b	1.281	0.000		0.327	0.000

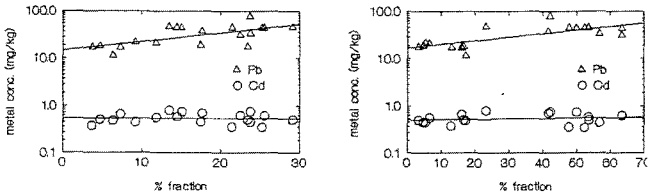


Fig. 1. Linear relationship between metal concentrations in whole sediment and percentage of fraction 20–54 µm (a), < 20 µm (b); r = correlation coefficient; P = significance; b = coefficient from equation y = bx + a.

From correlation coefficients, it might be concluded that the levels of Pb in various fraction of the sediment from the Kastela Bay are controlled by organic matter content in the same fraction, and Pb is chemically associated with various phases of organic matter present in the sediment, while, it is unlikely in the case of Cd (Fig.2).

a)	Pb	Cd	b)	Pb	Cd
r	0.657	0.501		0.769	0.593
P	0.034	0.269		0.009	0.228
b	3.840	0.005		4.662	0.006

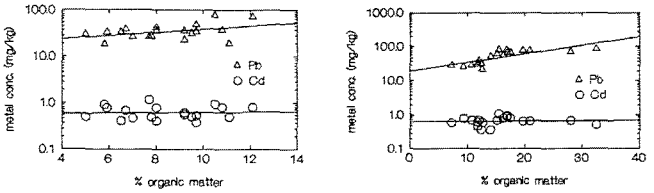


Fig. 2. Linear relationship between metal concentrations in each fraction and organic matter content in the same fraction: 20–54 µm (a), < 20 µm (b); r = correlation coefficient; P = significance; b = coefficient from equation y = bx + a.

Lead and Cd concentrations in the sediment is far less affected by fraction content than by organic matter content (Fig. 1 and 2). In all sediment layers, Pb and Cd concentrations increase with increase of organic matter, particularly in the fine–grained sediment fraction (< 20 µm). Lead concentrations in the sediment is surface sediment (0 – 5 cm)is two times higher compared to Pb concentrations obtained in the sediment layer between 20 and 25 cm below the sediment–water interface. The concentrations of the metals in the deepest layer of the sediment was taken as background. The obtained concentrations of Cd are similar to the values early reported : means value Cd–0.405 mg/kg and Pb – 36.00 mg/kg, (VUKADIN *et al.*, 1982). Obviously Pb concentrations have increased in the past ten years.

REFERENCES

BROOK E. J. and MOORE J. N., 1988. Particle-size and chemical of As, Cd, Cu, Fe, Mn, Ni, Pb and Zn in bed sediment from the Clark Fork River, Montana (U.S.A.). *Sci. Total Environ.* 76 : 247–266.

DONAZZOLO R.*et al.*, 1981. Heavy metal contamination in surface sediments from the Gulf of Venice, Italy. *Mar. Pollut. Bull.* 12: 417–425.

MARTINCIC D, KWOKAL Z. and BRANICA M., 1990. Distribution of zinc, lead, cadmium and copper between different size fractions of sediments I. The Limski Kanal (north Adriatic Sea) *Sci. Total Environ.* 5: 201–215.

SCHNEIDER B. and WILER K., 1984. A quick grain size correction procedure for trace metal contents of sediments. *Environ. Techn. Lett.* 5: 245–256.

VUKADIN I., STEGNAR P. and SMODIS B., 1982. Fate and distribution of toxic heavy metals in sediments and organisms of Kastela Bay. *Acta Adriatica.* 23: 307–312.

DETERMINATION OF SOLUBILITY PRODUCTS AND SATURATION CONDITIONS OF SALTS PRECIPITATED DURING SOLAR SALT PRODUCTION

Vesna VANCINA[1], Halka BILINSKI[2] and Dana R. KESTER[3]

[1] Faculty of Graphic Art, University of Zagreb, Zagreb, Croatia
[2] Ruder Boskovic Institute, Zagreb, Croatia
[3] Graduate School of Oceanography, University of Rhode Island, Narragansett, R I 02882 USA

During production of NaCl at the solar salt work in Seca, Portotroz, Slovenia, some macro- and microconstituents of seawater are concentrated in brines and some in brines and in sediments. Liquid samples collected at the solar salt work were : incoming seawater, brines of various densities from evaporation, lime, pickle and crystallising ponds and residual brines or bitterns from bittern storage. Solid samples collected at the solar salt work were : cumulative sediments from evaporating, pickle and crystallising ponds. Microcomponets were determined by X-ray fluorescence spectroscopy. Macrocomponents were determined as follows : sodium, potassium and magnesium by atomic absorption specrometry, calcium and magnesium by complexometric titration with EDTA, bromide by volumetric titration with $Na_2S_2O_3$, chloride by modified Mohr's titration, and sulphate gravimetrically as $BaSO_4$. The activity coefficients of macrocomponets have been calculated from analytical data at various brine densities employing Pitzer's approach for mixed electrolytes. These coefficients were used together with the measured molar concentrations to calculate the solubility products of precipitating salts during production of NaCl at the solar salt work. The values obtained were compared with those from the literature reported for low ionic strength.

ACKNOWLEDGEMENT.
We thank Dr. V. Valkovic, Dr. I. Orlic and M. Nagj, M.Sc. for X-ray fluorescence measurements.

C

NUTRIENT ENRICHMENT AND BIOLOGICAL RESPONSE IN THE ADRIATIC COASTAL SEA

I. VUKADIN, L. STOJANOSKI, I. MARASOVIC, T. PUCHER-PETKOVIC
Institute of Oceanography and Fisheries (IOF), 58000, Split, Croatia

The Institute of Oceanography and Fisheries have, for the past ten year, been involved in the research of the coastal waters of the middle Adriatic (from Zadar to Dubrovnik). This research has been undertaken to establish the impact of land factors (river and waste water runoffs), on the one hand, and of the open sea–water, on the other, on chemical and biological properties of the adjacent sea.

The studies of chemical hydrography, nutrients, chlorophyll *a* and primary production (*in situ*) point to the fact that, for the past decade, an increase in the eutrophication level has persisted in all the areas, except in the area of Dubrovnik which is still affected by the open sea. A marked trend of increase of some nutrients (nitrate and nitrite) along with temporary occurrences of higher quantities of other nutrients has been recorded from the areas of Sibenik and Ploce. These areas are also characterized by markedly high productivity and phytoplankton biomass, presumably due to the effects of fresh water inputs by the rivers Krka and Neretva respectively as well as to urban sewage effluent disposal. Considerable changes have been recorded in the Split area ecosystem, particularly in Kastela Bay. Here, the eutrophication intensification is presumably closely related to urban waste water runoffs which have been constantly increasing. Red tide has frequently been recorded from these areas, devastating them seriously. Therefore these problems call for intensive future investigations which would help to establish the causes and effects of these phenomena.

C

Stat.	Parameters								
	T°C	Sx10³	$O_2cm^3dm^{-3}$	NO_2-N	NO_3-N	NH_3-N	PO_4-P	SiO_3-Si	N/P
Z-1	18.99	37.78	5.63	0.98	0.089	0.76	0.046	3.33	35
Š-1	19.12	34.09	5.58	1.25	0.134	1.22	0.105	7.14	33
S-1	18.82	37.38	5.62	0.87	0.087	0.78	0.064	4.19	45
P-1	19.52	35.51	6.11	0.90	0.121	0.82	0.062	4.20	35
D-1	18.99	38.06	5.79	0.82	0.094	0.61	0.062	4.09	30
I.Vis	17.70	38.51	5.47	1.09	0.093	0.73	0.062	3.09	31

Table 1. Mean summer values of hydrographic parameters, and nutrients (m mol m^{-3}) on investigated areas.

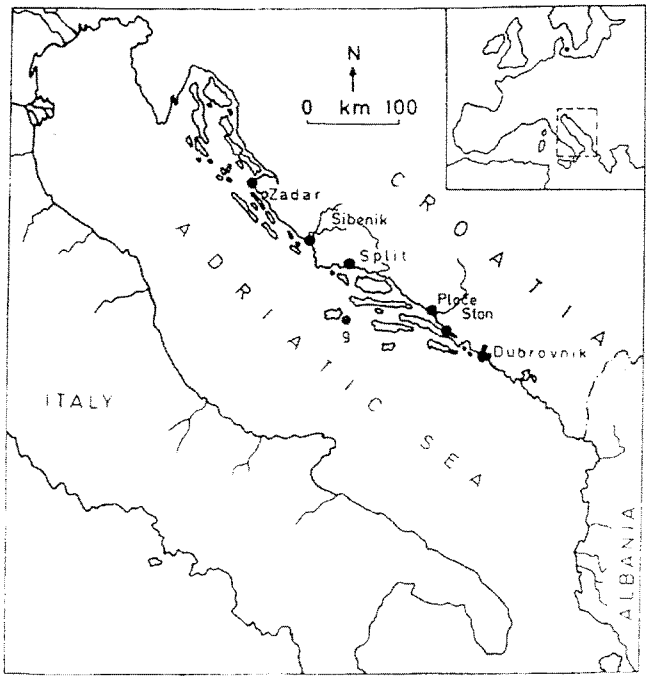


Fig. 1. Study area

REFERENCES:

Analiza rezultata istrazivanja projekta "Vir–Konavle" u razdoblju 1984–1991 god. Elaborat–IOR–Split, 1992.

VUKADIN, I. 1991. Hydrographic and Biological Aspects of Algal Bloom in Adriatic Sea in 1988. Toxicological and Environmental Chemistry. Vols 31–32 : 265–274.

ZORE–ARMANDA, M. M. BONE, V. DADIC, M. MOROVIC, D. RATKOVIC, L. STOJANOSKI and I. VUKADIN., Hydrographic properties of the Adriatic Sea in period from 1971 through 1983. *Acta Adriat.* Vol. 32 : 1–547.

E

COMITÉ
ÉTANGS SALÉS ET LAGUNES

Président : Maria Rosa MIRACLE
Vice-Présidents : Francesco SACCHI,
Antonio ARIANI, Romano AMBROGI

EFFECT OF SOME ENVIRONNEMENTAL AND PHYSIOLOGICAL FACTORS ON THE GONADAL HISTOLOGY OF *MUGIL CAPITO* DURING THE BREEDING SEASON

BAGHDADI H.H., ZAKI M.I., EL-GHARABAWY M.M. and EL-GREISY A.A.

National Institute of Oceanography and Fisheries, Alexandria, Egypt

During the breeding season, experimental changes in some environmental factors were accompanied by histological changes in the gonada of *Mugil capito*. In an attempt to evaluate the role of environment in reproduction of *Mugil capito*, photoperiod, temperature and salinity controlled experiments were conducted between mid October and late December, during the breeding season.

Histological changes were observed in the present work due to the effect of the studied factors. In the female, the control group which was subjected to the natural conditions showed that the ovary of *Mugil capito* was filled with hyalin oocytes and some imature oocytes in the period of study (spawning season). By increasing the photoperiod, the atretic oocytes predominated and many vacuaoles appeared. At continuous darkness, the ovary also becam atretic with many large vacuole.

The oocytes were also affected by the temperature. At 15°C, the yolk was resorbed and a big vacuole was observed in the middle of most oocytes. At 20°C, resorption of the yolk was observed, the oocytes became collapsed with the appeearance of a very big vacuole in the middle of the oocytes.

The salinity developed the oocytes at 25‰ salinity. At higher salinity, the imature oocytes become developped. The HCG injection developped the oocytes within one week of the injection. Most of them were observed in the hyaline form. After 10 weeks of the injection, the yolk resorbed and the atretic oocytes predominated.

The result of the present investigation is in agreement with many results, as KADMON *et al.*, (1985) who studied the effect of 2 photoperiod regimes on the gonada of *Sparus auratus* (L.). They found a clear inhibition of gonadal recrudescence under long photoperiod (16L+8D). On the other hand, short photoperiod (6L+18D) initiated vitellogenesis in *Mugil cephalus* (KUO *et al.*, 1974).

In the present investigation, the acclimation of *Mugil capito* to different degrees of salinity or even to the sea water without hormonal intervention was not sufficient for the spawning of this species in captivity. Hence, the present investigation sugests that the *Mugil capito* cannot breed without a combination between more than one factor.

REFERENCES

KADMON G., YARON A. and GORDIN H. 1985. Sequence of gonadal events and estradiol levels in *Sparus auratus* (L.) under two photoperiod regimes. *J. Fish Biol.*, 26 : 609-620.

KUO C.M., NASH C.E. and SHEHADEH Z.H. 1974.The effects of temperature and photoperiod on ovarian development in captive grey mullet (*Mugil cephalus* L.). *Aquaculture*, 3 : 25-43.

CONTRIBUTION A L'ÉVALUATION DE L'IMPACT DE LA POLLUTION SUR LA CARCINOFAUNE BENTHIQUE DE LA LAGUNE MÉDITERRANÉENNE DE NADOR (MAROC)

El Houssine BOUSSELLOUA[1] et Mohamed MENIOUI[2]

[1] Faculté des Sciences de Kenitra, B.P. 133, Kenitra, Maroc

[2] CNR, B.P.. 8027, Rabat, Maroc

La lagune de Nador (35°7'N à 35°16'N et 2°44'W à 2°80'W) est la seule lagune méditerranéenne du Maroc et la plus grande des lagunes marocaines (115 Km^2). Cette étude vise l'évaluation des effets de la pollution sur la carcinofaune benthique. Le choix des stations (Fig. 1) repose principalement sur les apports continentaux liés aux eaux usées (D1, D2, D3, D4, D5 et M2) ou aux substances solides en provenance de "dépotoirs" (D4, M3, M4), la nature du substrat (dur ou meuble), avec ou sans végétation et l'hydrodynamisme qui définit des zones confinées (M1, M3 et M4). Les stations D4 et D5 ont été choisies sur le bassin de stockage (Fig.1.B) où stagnent les eaux usées avant leur transfert par une canalisation terrestre vers le système de lagunage (Fig.1C) où quatre stations ont été choisies (D1, D2, D3 et M2). Une station témoin (T), non polluée,a été choisie sous le mont d'Atalayoune. Le traitement des données a été effectué par l'Analyse Factorielle des Correspondances. Les 89 prélèvements effectués ont fourni 25 espèces seulement, réparties sur 5 groupes systématiques dont 16 Amphipodes (56%) et 6 Isopodes (24%). Les Tanaidacés (3 espèces), les Décapodes et les Cirripèdes (1 espèce chacun) constituent 20% du total.

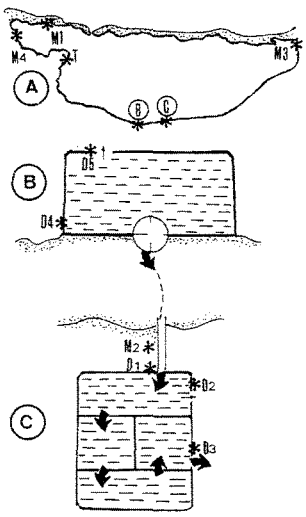


Fig.1. Localisation des stations dans la lagune (A), dans le bassin de stockage (B) et dans le système de lagunage (C).

L'analyse des données (Fig.2) montre que, dans le plan factoriel F1*F2, l'axe F1 (44,8%) exprime le principal paramètre régissant la distribution des espèces dans différentes stations qui est la pollution. Cet axe est, en effet, expliqué à près de 81% par la seule station témoin (T), isolée à son pôle positif. Elle est accompagnée par un cortège d'espèces des eaux saumâtres (*Tanais dulongii, Parasinolobus chevreuxii, Idotea baltica, Leptochelia savignyi, Cymodoce spinosa, Gammarus insensibilis* et *Colomastix pusilla*); mais, aussi, par des espèces des zones franchement marines (*Dexamene spinosa, Amphitoe ramondi, stenothoe monoculoides, Dexamene spiniventris; Maera grossimana*) et même des espèces des eaux pures dont *Hyale schmidti*. Alors que du côté négatif de l'axe F1 sont groupées les autres stations situées, toutes, à proximité de sources de pollution et, avec elles, toutes les autres espèces, qui, selon CRAWFORD (1937), ROME (1942), DIVIACCO et RELLINI (1981), SCIPIONE *et al.* (1981), HOLDICH et JONES (1983) et MENIOUI (1988), sont suspensivores ou détritivores et liées aux algues vertes, aux substrats plus ou moins vaseux riches en débris végétaux, ainsi qu'aux milieux pollués où les facteurs du milieu sont très variables. Il s'agit, entre autres, de *Corophium insidiosum, Balanus montagui* ou encore *Dynamene edwardsii* connue comme indicatrice de pollution (HOLDICH, 1970). L'axe F2 (23,6%) paraît exprimer un double gradient. Il isole de son côté positif les trois stations ayant la caractéristique commune d'être situées dans des zones confinées, calmes ou même stagnantes, à l'extrémité NW (M4), à l'extrémité SE (M3) et au fond d'un bras mort sur la digue qui sépare la lagune du large (M1). Le phénomène d'eutrophisation y est important, accentué par des apports solides dus à la proximité de dépotoirs. Trois espèces caractérisent ce groupement : les gammariens *Gammarus aequi-cauda* et *Gammarus subtypicus* et l'isopode *Cymodoce truncata*. Du côté négatif de cet axe et à proximité du barycentre sont groupées des stations de substrat solide (D1, D2, D3, D4 et D5) ou meuble (M2) caractérisées par la proximité d'une source d'eaux usées où l'hydrodynamisme est relativement intense. Il en découle que la majorité des stations étudiées sont plus ou moins diluées par les eaux douces mais enrichies par les apports continentaux d'origine domestique et les espèces qui y sont inféodées sont liées à l'abondance de matière organique en suspension dans l'eau, telles que *Balanus montagui*, espèce suspensivore par excellence, *Erichtonius punctatus*, espèce très euryhaline préférentielle des fouling et des pollutions d'origine anthropiques (RUFFO, 1991) ou encore *Dynamene edwardsii*, réputée d'indicatrice de pollution qui, en plus, abonde dans les milieux lagunaires faiblement alimenteés en eau du large (HOLDICH, 1970). La méthode de l'A.F.C. permet de mieux dégager la typologie d'un milieu lagunaire et la répartition préférentielle des espèces en fonction des types de pollution. Aussi, la lagune de Nador, de par sa liste faunistique, s'avère très pauvre, appauvrissement qui s'accentue avec les apports continentaux et l'eutrophisation. Ce milieu souffre de deux types de pollutions, l'une d'origine domestique due aux eaux usées et l'autre "naturelle" due à la fermeture progressive de la passe et à l'insuffisance du brassage de l'eau, en particulier, aux extrémités de la lagune. Ces dernières, utilisées comme dépotoirs, sont enrichies en éléments nutritifs qui intensifient le phénomène d'eutrophisation. Enfin, deux espèces sont signalées pour la première fois dans des eaux marocaines; il s'agit de *Gammarus subtypicus* et *Erichtonius punctatus*.

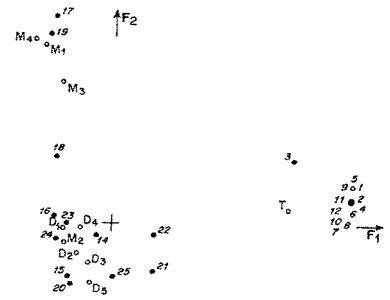


Fig.2. Distribution des stations et des espèces dans le plan factoriel F1*F2

RÉFÉRENCES

HOLDICH D.M. et JONES J.A. 1983 - British Tanaids keys and notes for the identification of the species. *Synop. British Fauna*. 27: 93 p.

MENIOUI M. 1988 - Contribution à la connaissance des peuplements infralittoraux superficiels des côtes atlantico-méditerranéennes du Maroc. Thèse Doc. Etat, Univ. Mohamed V, Rabat, 256p.

E

SPECIFIC DIVERSITY OF PHYTOPLANKTON IN A NORTHERN ADRIATIC COASTAL LAGOON

Marina CABRINI[1], Sara COK[1], Irene PECCHIAR[1] and Serena FONDA UMANI[2]

[1]Laboratory of Marine Biology, Trieste, Italy
[2] Department of Biology, University of Trieste, Italy

In the North Adriatic Sea the main brackish areas are located in its Eastern part : the lagoon of Venice and the lagoons of Grado and Marano. The first studies on phytoplankton of the Marano and Grado lagoons are dated 1976 (TOLOMIO, 1976); recently FONDA UMANI and SPECCHI (1983) and CABRINI *et al.* (1993) have integrated researches on these environments, in order to gain a better understanding of the biological community. The trophic availability of this ecosystem, due to the primary production, substains an intensive acquaculture activity and therefore it is necessary to assess the specific phytoplankton composition and its abundance. The specific diversity and the biomass are influenced by the effects of tide hydrodynamism and the chemical-physical factors, particularly salinity.

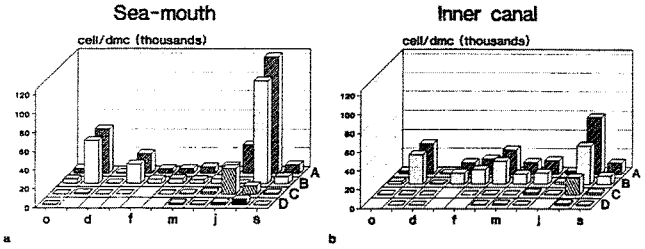
To continue the previous observations, a study on seasonal dynamics of phytoplankton was carried out from October 1990 to September 1991. In two stations in the Marano lagoon, environmental parameters were recorded and samples of surface water were collected to determine the microalgae according to the Utermöhl method. The first station was located near one of the mouths of the lagoon, the second one in its inner part. On phytoplankton matrices we applied three indexes of specific diversity to characterize the richness (Margalef), equitability (Pielou) and diversity (Shannon) of the two stations (GANIS, 1991).

Phytoplankton data do not allow us to pinpoint any typical lagoon community, but show that a few marine species can survive in such a variable environment. The diatoms are dominant in this ecosystem (Fig.1 a and b); *Cerataulina pelagica* with 89200 cells/l and *Nitzschia gr. Pseudonitzschia* with 45200 cells/l, are the most abundant species. The dinoflagellates are usually scarce; the highest value is reached by *Prorocentrum minimum* with a maximum of only 19920 cells/l. *Cryptophyceae, Prymnesiophyceae* and *Euglenophyceae* are also found, but always in low concentrations.

Among the identified species, eleven are present in both stations, another thirteen are present at the sea mouth, while only three are typical of the inner canal. In this station the Pielou index presents elevated values that shows an equidistribution of the species during the year. The specific diversity is always rather low in both stations and the highest values of the Shannon index, with a maximum of 1.737, are reached in the inner part of the lagoon. In this site both the richness and the microalgal biomass are low. The station on the sea-mouth presents lower values of the Shannon index than in the inner canal, but the Margalef index and the cell density are generally higher.

The phytoplankton of the Marano lagoon is not a typical brackish microalgal community and the specific diversity increases from the sea mouth to the inner canal. In summer and autumn the highest biomass is found in the outer part of the lagoon, while in spring it is more abundant in the inner station. However the phytoplankton density is not very high if referred to the sea coastal community. In spite of this the mariculture activities are intensive in this lagoon, substained probably by small species belonging to picoplankton fraction. The specific composition and the biomass of this component, till now not well known, should be considered in future researches.

Fig. 1 (a and b) : A = Total phytoplankton; B = Diatoms; C = Dinoflagellates; D = Others.



REFERENCES

TOLOMIO C. 1976.- Problematica e dinamica del fitoplancton nelle acque salmastre. Arch. *Oceanogr. Limnol.*, 18 suppl.: 343-356.

FONDA UMANI S. & SPECCHI M. 1983.- Two years research in the Lagoon of Marano (North Adriatic Sea). *Rapp. Comm. Int. Mer. Medit.*, 28, (6): 247-249.

CABRINI M., COK S. & TULLI F. 1993.- Seasonal dynamics of phytoplankton in the lagoon of Marano (Northern Adriatic Sea). *Gior. Bot. It.*, 127, (4): 847-849.

GANIS P. 1991. - La diversità specifica nelle comunità ecologiche: concetti, metodi e programmi di calcolo. GEAD-EQ n. 10: 100 pp.

LIFE CYCLE AND DIET OF TWO PIPEFISH (SYNGNATHIDAE) IN THE STAGNONE LAGOON (NW SICILY)

M. CAMPOLMI[1], P. FRANZOI[2], V. COTTARELLI[2], A. MAZZOLA[1]

[1] Istituto di Zoologia, Università di Palermo, Sicily
[2] Dipartimento di Scienze ambientali, Università della Tuscia, Viterbo, Sicily

Pipefish commonly inhabits shallow vegetated waters in coastal and estuarine areas, where they form a large component of fish assemblage associated with macroalgae and macrophitae beds. We investigated population structure, life cycle and food niche segregation of *Syngnathus abaster* Risso, 1826 and *S. typhle* Linnaeus 1758, in a Mediterranean coastal lagoon. Pipefish were collected in the Stagnone di Marsala, this biotope, located in the western part of Sicily, is characterized by phanerogame and seaweed beds. Wide salinity and temperature fluctuations are recorded during the seasonal cycles. Monthly samplings were carried out from January to December 1993 by means of a beach seine 15 m long (4 mm mesh size in the bag), in six stations characterized by sandy and/or muddy bottom showing a patchy submersed vegetation (mainly *Cymodocea nodosa* beds but also *Caulerpa prolifera* and *Cystoseira spp.*). Samples were preserved in 10% neutralized formalin, species were sorted out in order to record standard length and weight. Syngnathids were sexed by presence or absence of a male brood pouch. Fecundity of ripe females and brooding males was estimated: the mean number and diameter of oocytes and eggs. Brood pouch length in males and standard length at birth were also measured. Gut contents analysis was performed on subsamples collected in July and October. Food items were classified and counted. Percent numerical abundances and frequencies of occurence per food item were calculated; Renkonen measures of niche overlap between the two pipefish populations in July and October were calculed too. The average number of different food items per gut has been considered as a measure of individual food niche breadth. Analysing the population structure of these pipefish for both species the occurence of two cohorts per year was evident: the parent cohort (age 1+), and the recruit cohort (age 0+). The newly-born fish of both species appeared in May and were present until the end of October. The occurence of more subcohorts of age 0+, suggests that females are batch spawners and males can incubate several broods during the breeding season. Tab.1 shows a comparison between some life-history traits of these pipefish. In females several batches of oocytes in different maturity stages were observed. The number of oocytes increased with female body size, also the number of eggs incubated by males increased with brood pouch size. Diet compositions of both pipefish species are reported in Tab.2. Feeding habits of *S. abaster* and *S. typhle* are seemingly different: *S. abaster* preyed mainly on zoobenthos, especially harpacticoids of genus *Tisbe* and to a lesser extent on Amphipods (Gammaridea, Caprellidea), Isopods *(Idotea* sp., *Sphaeroma* sp., Arcturidae), Tanaidacea and Ostracods. *S. typhle* fed especially on Misyds, a macroplanktonic prey that in shallow waters occupies the entire water column, from surface to bottom. *S. abaster* and *S. typhle* are among the most typical representatives of Stagnone fish community. The continued capture throughout all the year, the presence of juveniles and the occurence of males brooding embryos all suggest the existence of established, breeding populations of both species. These pipefish belong to the resident species group and show abbreviate iteroparity ("sensu" Miller, 1984), namely: short life span with only one or few reproductive seasons; increased parental care; in addition females spawn several times and males are able to hatch subsequent batches of eggs during the same breeding season. *S. abaster* and *S. typhle* seem to avoid competition for food, showing different foraging microhabitats. Food niche differences pointed out between these pipefish species may be related to snout morfology. *S. typhle* snout is longer, *S. abaster*'s is shorter and conical; this enables the former species to catch relatively fast pelagic preys, the later to prey small organisms hiding themselves in the submersed vegetation (FRANZOI *et al.*, 1993).

TAB.1- Life cycle traits

Species	*S. abaster*	*S. typhle*
No. tot ind.	277	321
Occurence of juveniles	end MAY- OCT	begin MAY- OCT
Breeding season	MAR-OCT	APR- OCT
S.L. max (mm)	106	229
Sex-ratio (Males/Females)	0.46	0.198
No. of eggs/ Male (S.L.range mm.)	(74-96)	(130-150)
(mean ± SD; n=5)	27 ± 4.08	51 ± 11.8
No. of oocytes/Female (S.L.range mm.)	(74-96)	(130-150)
(mean ± SD; n=5)	29.5 ± 6.45	73.6 ± 38.4
Eggs diameter (mm)		
range (mode)	1-2 (1.3-1.5)	0.8-2.5 (2-2.5)
Oocytes diameter (mm)		
range (mode)	0.3-1.3 (1-1.3)	0.8-2 (1.7-2)
Average length of		
brood pouches (mm)(S.L.range mm.)	(74-96)	(130-150)
(mean ± SD; n=5)	24.5 ± 2.38	44 ± 4
Average S.L. at birth (mm)	(N=10)	(N=10)
(mean ± SD; n=5)	18.2 ± 0.5	19.5 ± 0.4

TAB.2- Gut content analysis

Sample month	July		October	
Species	*S. typhle*	*S. abaster*	*S. typhle*	*S. abaster*
No. of fishes	10	10	10	10
SL range (mm)	85-157	60-76	67-140	63-86
Average no. of prey per gut (SD)	11.0(2.0)	8.8(20.0)	1.8(0.9)	19.1(14.9)
Average no. of food items per gut (SD)	1.2(0.4)	3.3(1.4)	1.0(0.0)	3.4(1.9)
DIET COMPOSITION(%Number of prey)	N%	N%	N%	N%
GASTEROPODA	4.5	0.6		
ACARINA				0.65
OSTRACODA		6		1.3
COPEPODA HARPACTICOIDA		71.3		66
MYSIDACEA	87.9	1.3	84.6	1.3
TANAIDACEA		3.3		5.9
ISOPODA:				
Idoteidae		7.3		1.3
Sphaerominae		1.3		6.5
Arcturidae				0.7
AMPHIPODA:				
Gammaridea		8.7	15.4	15.7
Caprellidea				0.7
OSTEICHTHYES (post-larvae)	7.6			
RENKONEN INDEX	July: 2.0		October: 16.7	

REFERENCES

FRANZOI P., R. MACCAGNANI, R. ROSSI, V. U. CECCHERELLI, 1993. Life cycles and feeding habits of Syngnatus taenionotus and S. abaster (Pisces, Syngnathidae) in a brackish bay of the Po River Delta (Adriatic Sea). *Mar. Ecol. Prog. Ser.*, Vol. 97: 71-81.

MILLER P.J., 1984. The tokology of Gobioid Fishes. In: Fishes reproduction: strategies and tactics, (eds. Potts G. W., Wootton R.J.). Academic Press, Harcourt Brace Jovanovich Publishers, London, 119-153.

This research was supported by a M.R.A. grant (1994).

CYANOPHYTA IN HYPERSALINE SOLAR SALTERN PONDS (EBRO DELTA, SPAIN)

CLAVERO E.[1], MERINO V.[2], GRIMALT J.O.[1] & HERNÁNDEZ-MARINÉ M.[2]

[1] Department of Environmental Chemistry (CID-CSIC). C/Jordi Girona, 18.
[2] Lab. of Botany. Fac. of Pharmacy. University of Barcelona. Av. Joan XXIII, s/n. 08028 Barcelona, Spain.

Microbial mats develop in hypersaline environments. One category of these mats are solar saltern ponds used for salt exploitation. This paper describes the cyanophyta assemblages thriving at the Salinas de La Trinitat, located at the Ebro delta (40°35'N, 0°40'E, South Catalonia, Spain). The structure of the sediment of these mats has been reported elsewhere (CLAVERO *et al.*, 1994; DE WIT *et al.*, 1994). Ponds are generally fully flooded in April. Seawater enters and is stored in the "deposits" and then transits through a series of shallow water pools in which the salinity of the water increases due to evaporation. Field observations and sampling were made sporadically from 1991 to 1993 and monthly in 1994. Four zones, distinctly different in salinity, were chosen for sampling and examination. Salinities and the dominant microbiota distribution are given in Fig. 1.

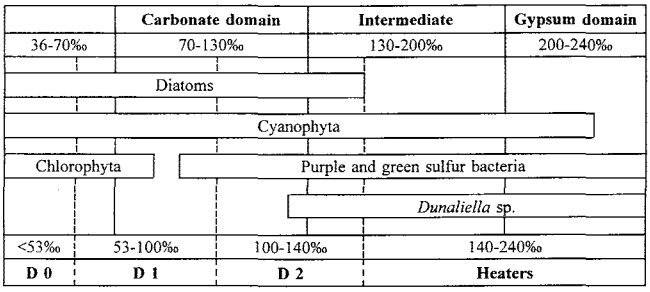


Fig. 1. Salinity of the different sampled pools and microbiota distribution

Deposit 0. The low salinity did not allow mat establishment. However, in spring and summer, in the sand floor rooted *Ruppia maritima* L. and green filamentous alga developed. Among them grew *Chroococcus minutus* (Küt.) Näg., *C. turgidus* (Küt.) Näg., *Gomphosphaeria salina* Komárek et Hindák, *Johannesbaptistia pellucida* (Dick.) W.R. Taylor *et* Drouet, *Phormidium hypersalinum* Campbell *et* Golubic, *Lyngbya aestuarii* Liebm. and *Merismopedia glauca* (Ehrh.) Näg. The temporarily flooded sides were colonized in spring by a distinct laminated mat of a few mm; the upper layer was orange in colour and was formed either by sand and diatoms or sand and filamentous degraded sheaths, depending on the salinity of the evaporating water cover. The second layer was made up by *L. aestuarii* and *L. martensiana* Menegh., *Oscillatoria limosa* Ag. and *Hydrocoleus lyngbyaceus* Kütz., and the third layer was built mainly by *Microcoleus chthonoplastes* Thuret. When a shield was provided by stones or remains, a bright green layer of *M. chthonoplastes* stood on the surface and the other layers did not develop. As summer went on the flat slime covering dried and was broken into leathery desiccation polygons.

Deposit 1. There were very different populations, depending on the water column depth and the turbulence. In the margins that alternately were flooded and dried a compact layered green, grey and black mats were built, almost exclusively by *M. chthonoplastes*. On the inundated inner ring, a community began to develop in March which was mainly composed by diatoms and detrital particles that were associated with *C. turgidus* and scarce filaments of *L. aestuarii, M. chthonoplastes, Phormidium valderianum* (Delp.) Gom. and *Spirulina subsalsa* Gom. over a black sulfate-reduced layer. In summer they were substituted by a white and green dirty bed of *L. aestuarii* and *Beggiatoa* ssp., whereas the flooded sediment was coated by a thin mat dominated by *L. aestuarii* and *O. limosa*. Additional species were *Oscillatoria lacus-solaris* Campbell *et* Golubic, *Aphanotece cohenii* Campbell *et* Golubic, and *A. krumbeinii* Campbell *et* Golubic. This thin mat trapped oxygen bubbles, was detached and floated although none of the forming species had gas vesicles. Some Cladophora bulks were mixed up mainly with *L. aestuarii* ***and*** *L. martensiana*. In August, entrance of Deposit 0 water favoured mass development of dinoflagellates and *Tetraselmis* sp. Although at the end of the year (1991-93) *M. chthonoplastes* was dominant, a mat was not established.

Deposit 2. In November of the previous years a thick mat of *M. chthonoplastes* covered the pool. Changes in salinity and the storms of 1994 winter destroyed it, and in the spring small colonies of *A. cohenii* and *A. krumbeinii* were attached to the nude sand floor, along with filaments of *S. subsalsa*. The sizes of *A. cohenii* and *A. krumbeinii* individuals did not overlap. In summer the green-yellow colonies formed a discontinuous thin slime cover with some *M. chthonoplastes* and *O. lacus-solaris* filaments. Orange patches of mineral phases of oxidized iron and green layers of *M. chthonoplastes* were present in the reflooded margins, related to the seasonal changes in water level.

Heaters. In the spring of 1992 and 1993, with salinities between 120-140‰ the mat was mainly built by *P. valderianum* whereas in fall it was substituted by *M. chthonoplastes* and *S. subsalsa* overlaying red dots of Chromatium and a green lamina of sulfur bacteria. As the salinity increases up to 200‰ only soft yellow-brown flocculent mats of *A. krumbeinii* were attached to the saline calcareous substrate. This form is abundant in summer, even at lower salinities.

The entrance of water of low salinity to replace the loss by evaporation, in these man controlled environment, caused alterations on the community structure and composition. The thin established mats, especially those dominated by *L. aestuarii*, became detached from the sediment upon temporal flooding. At the onset of the inundation period some organisms show a rapid colonisation rate upon the establishment of the favourable conditions. They formed blooms that decreased in a few days leaving only a minor signal in the sedimentary record.

REFERENCES

CLAVERO E., GRIMALT J.O., MERINO V. & HERNÁNDEZ MARINÉ, M. 1994. Structure of the sediment at depositional saline environments. In: Lucas J. Stal & Pierre Caumette (eds.).Microbial Mats. Structure, Development and Enviromental Significance. *NATO ASI Ser.*, Vol. G 35 : 91-96. Springer-Verlag Berlin Heidelberg.

DE WIT R., GRIMALT J.O. & HERNÁNDEZ MARINÉ, M. 1994. Morphological and chemical transformations of Microcoleus chthonoplastes during early diagenesis in hypersaline microbial mats. Ibidem : 69-76.

PRELIMINARY STUDY ON OXYGEN AND REDOX PROFILES IN SEDIMENTS FROM THE LAGOON OF VENICE (ITALY)

J.K. COCHRAN[1], M. FRIGNANI[2], L. ZAGGIA[3] and R. ZONTA[4]

[1] Marine Sciences Research Center, The University at Stony Brook, N.Y., USA
[2] Istituto Geologia Marina, C.N.R., Bologna, Italy
[3] Dipartimento Scienze Ambientali, University of Venezia, Venezia, Italy
[4] Istituto Studio Dinamica Grandi Masse, C.N.R., Venezia, Italy

The concentration of dissolved oxygen is a sensitive indicator of diagenetic redox reactions occurring in the marine sediments. Microbial oxidation of organic matter in the sediment utilizes dissolved O_2 from interstitial water as the preferential electron acceptor. It can further proceed through a variety of alternate acceptors (as NO_3^-, Mn^{4+}, Fe^{3+}, SO_4^{2-}) until methanogenesis occurs (BERNER, 1980), and this sequence is marked by progressively decreasing redox potential (E_h). Oxygen also can be consumed by the oxidation of sulfide phases present in the sediments. Oxygen dissolved in the overlying water column can diffuse across the sediment-water interface to support this "sediment oxygen demand". When the consumption of O_2 in the sediment is large and its supply from the overlying water is limited, reduced conditions progressively extend toward the sediment-water interface, and hypoxia or anoxia in the overlying water column may even result. Redox potential profiles in surface sediment cores can be considered as an index of the imbalance between oxygen supply and its demand in the sediments (ZOBELL, 1946; CALLAME, 1968) but, due to chemical and thermodynamical limitations, E_h readings by Pt electrodes often do not provide meaningful information on specific redox equilibria. The interpretation of observed trends of E_h readings therefore requires the knowledge of the actual concentration of the chemical species involved. The present study was performed to investigate dissolved oxygen profiles in the near-bottom water and near-interface sediments of the Venice Lagoon, in order to evaluate the pattern of oxygen uptake in the sediments. A comparison was also made between measurements of dissolved oxygen and redox potential profiles, to investigate the relationship between the oxygen uptake and redox conditions in the sediment. Two sub-tidal areas of the Venice Lagoon, which had been previously characterized with respect to hydrodynamics, sediment characteristics and contaminant distribution, were chosen for the study. Sites were selected to be representative of the different sediment conditions. Four sites were in an eutrophied area near the Giudecca Isle, close to the City of Venice. The other 4 sites were in the Cona Marsh, the estuarine area of the Dese River, one of the main tributaries of the basin. The mean depth of the water column is about 0.5 m at all sites. Samples for dissolved oxygen measurement consisted of 7 cm diameter and 20 cm long undisturbed sediment cores, taken with overlying water. Dissolved oxygen was measured with a Clark-style microelectrode with guard cathode (Diamond General Development Corp.) (REVSBECH, 1989), mounted in a micromanipulator capable of vertical adjustement in mm, positioned about 1 cm above the sediment and gradually lowered in 0.5 mm increments. Redox potential profiles were measured in 4 cm-diameter cores at depths corresponding to 2, 5, 10, 20 and 40 cm from the core top, using combined Pt electrodes with a AglAgCl reference half-cell (201/L-SM-PT, CLR Milano, Italy) and following a previously tested methodology (ARGESE *et al.*, 1992). The Venice Lagoon represents an ecosystem in which coupling between the sediments and water column may be especially strong because of the organic-rich nature of the sediments and the shallow water column (mean depth of 0.5 m). One feature commonly observed in the oxygen microelectrode profiles is the production of dissolved oxygen by microalgae at the sediment-water interface (Fig.1, profile 1). Cores incubated in the dark overnight show the disappearance of this feature (Fig. 1, profile 2). Dissolved oxygen penetrates to less than 2.5 mm depth at all sites. Redox values at a depth of about 15-20 cm are similar (≈-180 mV) in all the investigated cores, which is a general feature in the sediment of the Venice Lagoon (ARGESE *et al.*, 1992; ZONTA *et al.*, 1994). The gradient between E_h values observed at 2 cm and at 20 cm may be taken as a measure of the extent of reduction of the upper sediment column, with large gradients indicating less reduction in the surface sediments. Oxygen penetration (Fig. 2) is correlated with the redox gradient, with the more reducing sediments of Cona having relatively shallow oxygen penetration depths. The Cona samples appear to have a different trend from those at Giudecca, in part due to differences in grain size and in the type and amount of organic matter for the sediment of the two areas. The data suggest that sediment oxygen demand is greater at Cona than at Giudecca and further studies to determine oxygen fluxes on incubated cores are planned.

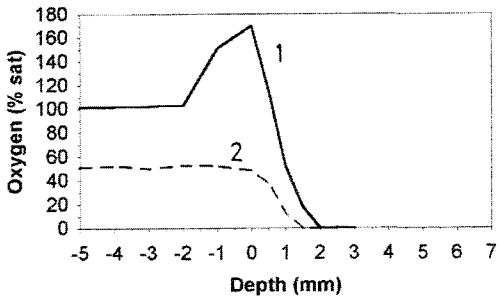


Fig. 1. Effect of oxygen consumption after overnight incubation in the dark.

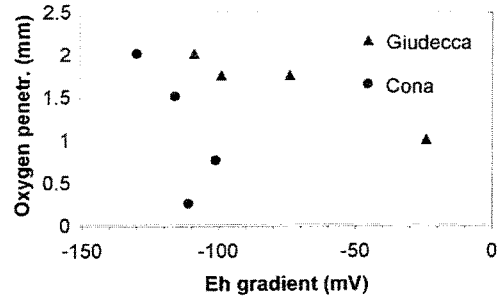


Fig. 2. Plot of the gradient between Eh values at 2 and 20 cm vs. the oxygen

REFERENCES

ARGESE E., COGONI G., PINI R., ZAGGIA L. and ZONTA R., 1992. Study on the Redox State and Grain-Size of Sediments in a Mud Flat of the Venice Lagoon. *Env. Geol. Water Sci.*, 20,1: 35-42.

BERNER R.A., 1980. Early Diagenesis. A Theoretical Approach. Princeton Univ. Press., 241.

CALLAME B., 1968. Contribution à l'étude des potentiels d'oxido-réduction dans les sédiments marins. *Cah. Oceanogr.*, 20:305-319.

REVSBECH N.P., 1989. An oxygen microsensor with a guard cathode. *Limnol. Oceanogr.*, 34: 474-478.

ZOBELL C.E., 1946. Studies on Redox Potential of Marine Sediments. *Bull. Am. Assoc. Petroleum Geol.*, 30 : 477-512.

ZONTA R., ARGESE E., COSTA F. and ZAGGIA L., 1994. Measurements of "tracer" parameters to investigate the environmental conditions in an area of the Venice Lagoon. Wetlands Ecology and Management, in press.

E

MONITORING FOR PROTECTION OF THE MARINE ENVIRONMENT USING LANDSAT-TM DATA

A.P. CRACKNELL[1], K. ABDULLAH[1],
J. N. HATZOPOULOS[2], M. KARYDIS[2], D. GAZIS[2]

[1] Depart. of Applied Physics Electronic & Manufacturing Engin., Univ. of Dundee, Scotland
[2] Department of Environmental Studies, University of the Aegean. Mytilene, Greece

This paper presents results from a joint project between the University of Dundee and the University of the Aegean. The project deals with the monitoring of the quality of the sea water environment using *in situ* measurements and satellite image data. The study was carried out using Landsat-TM data in Mytilene harbour and the surrounding water areas. *In situ* water samples were collected and analysed at the University of the Aegean during the year 1992 for the dates : 5 March, 9 June, 11 July and 28 August. Water samples were collected with a Van Dormsampler from the depth 0-1m. The water samples were used for chlorophyll and suspended matter determinations. Temperature and salinity was measured by a CTD instrument Model YSI 6000. Light transparency was recorded using a secchi disk and a KALSHICO digital underwater irradiameter model 268 WA 305. Samples for chlorophyll determinations were filtered immediately through millipore filters (pore size 0.45 um) after collection and the pigments of the filter were extracted overnight in 90% acetone. The samples were then centrifuged (3000 g for 30 min) and the chlorophyll absorption was measured in a double beam spectrometer Model Varian DMS-80. The detailed procedure is described by elsewhere (UNESCO-SCOR, 1966).

Suspended matter was measured gravimetrically according to the procedure described by STRICKLAND & PARSONS (1972). Estimates of suspended matter were also carried out by turbidity measurements using a Hach turbidity meter. Four Landsat-TM cloudless mini scenes (50x50 km coverage) were purchased corresponding to the *in situ* sampling dates. The position of the sampling boat was determined by photogrammetry and later by GPS. The image processing was performed at the University of Dundee (CRACKNELL *et al.*, 1994) in the following steps: (a) image rectification to a UTM 1:25000 scale map, (b) transformation from the sample location to image pixel scan lines, (c) the pixel values for bands 1, 2 and 3 were extracted for a 3 pixel by 3 pixel area corresponding to the sites of the *in situ* measurements and then they were converted to (i) radiance values and (ii) exoatmospheric reflectance values, and, the atmospheric correction was performed to the data using the darkest pixel method, (d) transformations such as the principal component, characteristic vector (using reflectance data) and chromaticity (using radiance data) were performed on the data sets, (e) multiple regression analyses were performed with dependent variables chlorophyll and suspended matter concentrations and their reflectance values. Two algorithms were then derived given by the Equations :

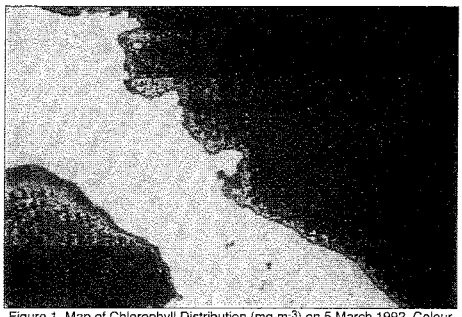


Figure 1. Map of Chlorophyll Distribution (mg m^{-3}) on 5 March 1992. Colour code: blue <0.1; green 0.1-0.4; yellow 0.4-0.7; orange 0.7-0.1; and red>1.1.

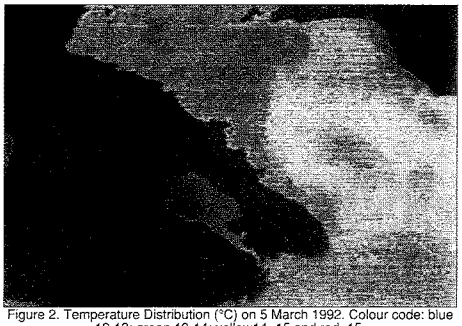


Figure 2. Temperature Distribution (°C) on 5 March 1992. Colour code: blue 12-13; green 13-14; yellow14- 15 and red>15.

$$y = a + \sum_{i=1}^{3} b_i r_i + b_2 r_2 + b_3 r_3 \qquad (1)$$

$$y = a + \sum_{i=1}^{3} b_i r_i + b_4 r_1 r_2 + b_5 r_1 r_3 + b_6 r_1 r_3 \qquad (2)$$

Where y is the concentration of chlorophyll or suspended matter, r_i is the reflectance value for band i and the coefficients a, b_i (i=1 to 6) are selected empirically and determined by the regression. Water quality maps were then generated by applying Equation (2) to all sets of data except June where Equation (1) was used. The distribution patterns of chlorophyll show that in March (Figure 1) a higher concentration occurred in the vicinity of Mytilene harbour and at some locations along the coast to the north and also in the coastal waters in the north eastern part of Kolpos Geras. Figure 2 shows the chlorophyll distribution for 11 July. Separate processing was applied to TM images of channel 6 to produce sea surface temperature (SST) maps which are shown in Figure 3 for the 5 March data set and Figure 4 for the 11 July data set. The algorithm used had the following form for all data sets (T_{sat} is the TM channel 6 value) :

$$SST = 11.1620 - 11.3132 \log(T_{sat}) \qquad (3)$$

This equation was produced by regression with correlation coefficient of 0.98 andan RMS error of ±0.8°C

REFERENCES

CRACKNELL A.P. K. ABDULLAH, J.N. HATZOPOULOS, M. KARYDIS and D. GAZIS, 1994 : Monitoring for Protection of the Marine Environment Using Landsat TM and AVHRR Data, Final Report to the British Council of Athens, Greece.

STRICKLAND J.D.H. & T.R. PARSONS, 1972 : A Practical Handbook of Sea Water Analysis. *Fish. Res. Bd. of Canada*, 167 (2nd Ed.).

UNESCO-SCOR, 1966 : Monographs on Oceanographic Methodology, I. Determination of Photosynthetic Pigments in Sea Water, UNESCO. Paris, pp. 69.

COASTAL LAGOONS ALONG THE COAST OF EGYPT WITH EMPHASIS ON BARDAWIL LAGOON

M. Hany S. ELWANY* [1], Ahmed KHAFAGY[2],
Abdel HAMID EL-LKANY[3], Alfy FANOS[2]

[1] Scripps Institution of Oceanography, La Jolla, CA 92093, USA
[2] Institute for Coastal Research, Alexandria, Egypt
[3] Faculty of Engineering, Alexandria University, Alexandria, Egypt

Egypt have a coast on the Mediterranean sea about 450 km long. 50% to 60% of the coast of Egypt is a low lying barrier beaches backed by large water lakes. There are one lake and 4 lagoons along the coast of Egypt. These are Lake Maryut and Idku, Burullus, Manzala and Bardawil Lagoons (Figure 1). All the lagoons are shallow with mean water depth about 2 m. Lake Maryut is not connected to the sea, however the other lagoons have channels to the Mediterranean sea (inlets) and when these inlets are open there are considerable circulation between open sea and these lagoons. The object of this paper is to give descriptions of these lagoons, their habitat value and to discuss their general hydrological characteristics.

The habitat value and productivity of shallow water lagoons are largely controlled by the circulations with the open ocean and within them. Often these circulations are determined by episodic tidal exchange with the open ocean. Typically shallow lagoons are closed to the ocean by the natural extension of beach berms across their inlet as a result of littoral sand transport along the neighbouring beaches. Occasionally these berms are broached by either high tides or excessive fresh water runoff. During periods of inlet closures, these lagoons progressively evaporate and become increasingly hypersaline.

Of special interest among these lagoons is the Bardawil lagoon. There is often vertical and lateral stratification in the Bardawil lagoon during this evaporative cycle with average rate of 2 m/year the salinities varies from 40 ppt to 90 ppt (Figure 2).

The Bardawil lagoon is 84 km length along the sea cost, 22 km maximum width and 1.75 to 2.6 m average depth. Its surface area is about 600 km at mean sea water level. This lagoon differs from the Nile Delta Lagoons in that it is of tectonic origin and not a deltatic lagoon. The only source of water into Bardawil Lagoon is the Mediterranean Sea through 3 inlets.

Measurements of water salinities, level and velocities were taken in the lagoon in 1972, 1973 and 1986 (BEN-TUVIA, 1984; CRI, 1988) in order to search for a method to keep the inlets open to the daily tidal flushing. The results of these measurements were utilized in this study along with a numerical model which use winds and tides time series as an input in order to attempt to explain the observed salinity structure of the lagoon.

Figure 1. Coast of Egypt. Notice the three inlets of the Bardawil Lagoon.

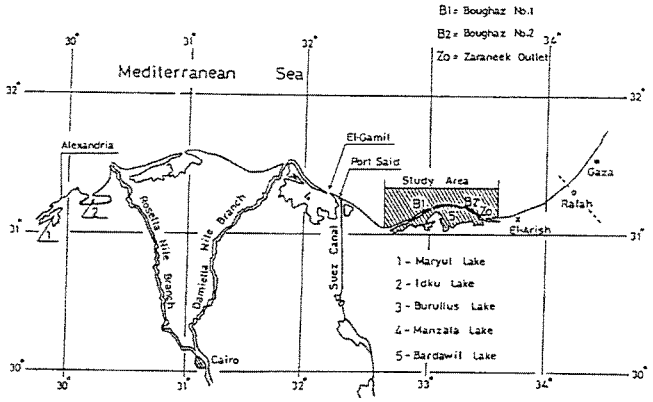
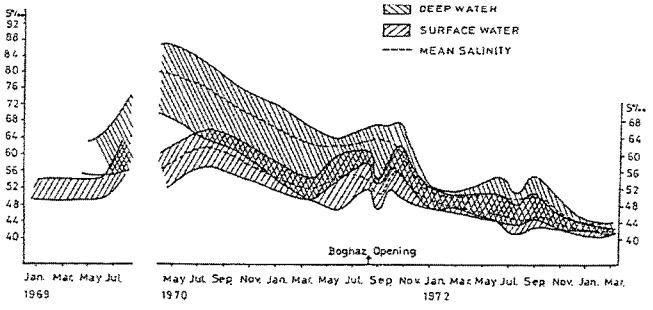


Figure 2. Time-series plot of salinity at Bardawil lagoon about 10 km east of B1.



REFERENCES

BEN-TUVIA, A., 1984. Some aspects of the management of Bardawil Lagoon. FAO, General Fisheries Council for the Med., *Studies and Reviews* 61(2) : 529 - 540.

COASTAL RESEARCH INSTITUTE AT ALEXANDRIA, 1988. Project of development Bardawil Lagoon fish resources, Final Report submitted to Academy of Scientific Research Cairo, Egypt.

TEXTURAL AND COMPOSITIONAL CHARACTERISTICS OF SUSPENDED MATTER IN THE LIGNANO BASIN (MARANO LAGOON, NORTHERN ADRIATIC SEA)

G.P. FANZUTTI, E. COLIZZA, F. FINOCCHIARO, R. MELIS and R. PIANI

Istituto di Geologia e Paleontologia, Università di Trieste, Italia

The aim of this study is the evaluation of the mean characteristics of the suspended matter of the Lignano basin (surface: 40 km^2; mean depth: 0.8 m), in the Marano Lagoon (Northern Adriatic Sea). Nine stations were sampled four times during 1991-1992 (October, February, April and July) along the channels of the basin, at lagoon inlet and at the Stella River mouth, which is the main spring-river, tributary of the lagoon (annual average discharge: 34 m^3/s). Surface and bottom samples were taken with a Niskin bottle, twice a day, during flood and ebb in spring tides without wind conditions.Temperature, salinity (CTD probe) and current speed measurements (NBA curremtmeter)were also collected.

The main parameters like total suspended matter (TSM), total carbonates andparticulate organic carbon (POC), C/N ratio, 5th percentile, modal and mean diameter are here presented. It was established their most frequent values so as their exceptional ones, showing the differences among the various lagoon environments: the basin, the inlet and the mouth of the Stella River.

For almost all the parameters a sistematic difference between the surface and the bottom was observed: concentration, mean diameter and carbonate percent values observed at surface are generally lower than those at the bottom. Likewise at the lagoon inlet (FANZUTTI *et al.*, 1992), this difference could be explained by the selective sedimentation within the water column of lagoon channels.

By observing the TSM frequency distribution, it can be established that the most frequent values are included in the band between 4 and 10 mg/dm^3 for the lagoon basin, those between 12 and 30 mg/dm^3 become less frequent, and those above 30mg/dm^3 should be considerated unusual. The last ones can be found mostly insurface during February and along the water column during July.

At each sampling, it was observed that the mean concentration values in the inlet are usually lower than those measured in the lagoon basin, whereas in the spring-river water values are similar to those of the lagoon. The only exception appears in October when the Stella River discharge was higher than the annual average and when at the inlet the resuspension phenomena due to the sea state areverified.

The frequency distribution of the POC in the lagoon basin shows a modal interval between 250 and 1000 µg/dm^3. Values lower than 250 µg/dm^3 are not found. The frequency of values higher than 1000 µg/dm^3 tend to decrease roughly, and likewise it is observed for the TSM, very high values at surface during February and along the water column during July are observed. At each sampling the lagoon inlet showed values equal or lower than those observed in the lagoon, while Stella River mouth (in normally discharge conditions) presents organic carbon values lower than those of the lagoon. In the lagoon, modal C/N ratio values range between 8 and 10.

The mean percent values of detrital carbonates in the basin are between 31.6% and 39.5%, while the range in the inlet is widely (29.5% in February and 42.5% inJuly). In the mouth of the Stella River the carbonate contents are slightly superior to those of the lagoon basin.

In the lagoon basin, the frequency distribution of grain-size parameters has allowed to establish that the most frequent values of the mean diameter are between 8 and 12 µm. As far as the modal diameter is concerned, values range from 10 to 12 µm, whereas for the 5th coarse percentile between 24 and 26 µm. Among all theseparameters, the mean diameter is the one that permits to differentiate the various environments. During ebb tide, the mean diameter in the inlet are higher with respect to the basin one, while during the flood the opposite phenomenon is observed.

The particulate matter brought from the Stella River is coarser (10 to 14 µm) than the lagoon one. This phenomenon is more evident in October sampling when the annual mean discharge was exceeded. Whether for the characteristics of the suspended matter or for the salinity distribution, the diffusion of the "plume" within the lagoon seems to be limited to a distance of about 2 km from the mouth (BELLI *et al.*, 1994).

BRAMBATI *et al.* (1990) recognized that a resuspension forced by the wind is one of the factors that mostly change the patterns of the TSM concentration in the Lignano basin. Since the data here presented are not influenced by wind resuspension, it was possible to indicate normal values during spring tides, while the exceptional values could be attributed to others phenomena below mentioned.

Anomalous values of POC found in February should be attributed to organic debris, as confirmed by the high values of C/N ratio and the low values of chlorophyll (FONDA UMANI, personal communication). The accumulation of organic debris within the basin could be due to the flood, typical of the late autumn season and to the degradation of the macro-algae that colonize the tidal flat. Its drastical removal is caused by the maximum (equinoctional) February tide excursions when wide zones of tidal flat emerge. The high concentrations of TSM found in July should be related to the resuspension caused by an intensive traffic of boats, which highly increases during the summer time in the resort area of Lignano.

This work is a step of a research that involves also ANPA-DISP (Rome) and Laboratorio di Biologia Marina (Trieste). It is supported by ENEA-DISP and MURST 60% "Ambienti Umidi" grants.

REFERENCES

BRAMBATI A., FANZUTTI G.P. and FINOCCHIARO F., 1990. Effetti della risospensione indotta da vento sulle concentrazioni e dimensioni del particellato nel bacino di Lignano (Laguna di Marano-Adriatico settentrionale). *Atti 8° Congr. AIOL* : 191-212.

FANZUTTI G.P., FINOCCHIARO F. and PIANI R., 1992. A comparison among some suspended matter characteristics in two tidal inlets of the Marano Lagoon (Northern Adriatic Sea). CIESM, *Rapp. Comm. Int. Mer Médit.*, 33, 400.

BELLI M., COLIZZA E., FANZUTTI G.P., FINOCCHIARO F., MELIS R., PIANI R. and SANSONE U., 1994. The role of a spring river as a source of Radiocaesium in a lagoonal environment: the case of the Stella river (Marano Lagoon, Northern Adriatic Sea). Int. Seminar on Freshwater and Estuarine Radioecology, Lisboa, 21-25 March 1994.

PHYSICO-CHEMICAL FEATURES AND NUTRIENTS DISTRIBUTION IN THE MARSALA LAGOON (ITALY)

Michele GIANI[1], Mauro MECOZZI[2], Cinzia GESUMUNDO[2], Giuseppina CIUFFA[2], Giuseppe SUNSERI[3], Franco ANDALORO[3]

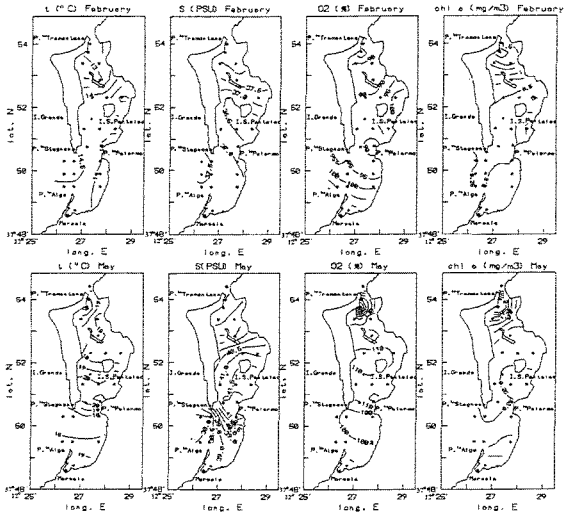
Istituto Centrale per la Ricerca Scientifica e Tecnologica Applicata al Mare, Chiogga[1], Roma[2], Palermo[3]. Italia

The Marsala lagoon (Stagnone di Marsala) extends over 20 km^2 along the western coast of Sicily. The average depth is about 1 m, the northern part is shallower (< 0.5 m) whereas the southern part reaches depths of more than three meters. Two mouths on the west and northern sides, wide 2.5 km and 0.4 km respectively, connect the lagoon to the sea. No river flows directly into the lagoon, whose waters are saline or hyperaline. Salt production basins are active along the eastern shore of the central part. The biocenosis of the lagoon are mostly those typical of marine environments and present some peculiarities as free-living forms of phyto- and zoobenthic species and sponge gigantism (CORRIERO, 1989). Water circulation driven by winds and tides acts in the north-south direction slowing down in the corridor between the three major islets and Isola Grande favored by the *Posidonia oceanica* mattes (RIGGIO *et al.*, 1983). Two surveys were carried out during May 1991 and February 1992. Temperature and salinity ranged from: 12.51°C and 35.87 PSU in February, to 21.67°C and 41.98 PSU, in May. The formation of a dense water core ($\gamma t > 29$ kg m^{-3}) in the central part of the lagoon during the spring survey was evident. The lagoon can be divided in three different parts on the basis of the temperature and salinity seasonal variations (considering our data and the former studies of CALVO *et al.*, 1986 and of CORRIERO *et al.*, 1989): a southern part with the lowest temperature and salinity variation, due to a high exchange with the sea, a central part where the highest temperature and salinity variations take place, due to a less intense water mass circulation and to the high evaporation during spring and summer and freshwater runoff during rain periods (limited to the east side); and a northern part subject to occasional riverine inputs and exchanges with the sea through the northern mouth. The differences in the physico-chemical features reflects on the biocenosis distributions, *Posidonia oceanica* is absent in the northern and central east part; the sponges which are abundant in the southern and central part are almost absent in the northern part (CEFALI & ANDALORO, 1979). The oligotrophy of the lagoon was confirmed during the February and May surveys but an increase of ammonium and chlorophyll *a* concentrations (up to 2-3 mg m-3) and oxygen oversaturation was observed mainly near the northern mouth of the lagoon (fig. 1). The nutrients concentrations are summarized in table 1. Dissolved inorganic nitrogen (DIN) constitutes about half of total dissolved nitrogen and ammonium constitutes 56% (in February) and 68 % (in May) of DIN. Ammonium concentrations resulted more elevated in February in the northern part near the acquaculture plant water discharges whereas elevated silicates, nitrates and nitrites were found in the central part in connection with minimum salinities values (fig.1). The north-west zone of the lagoon, once colonized by *Cymodocea nodosa* and *Caulerpa prolifera* (CALVO *et al.*, 1980), now is being covered by *Ulva* spp., which is colonizing the southern part of the lagoon near the town of Marsala, too. The distribution of this nitrophilic algae was reported previously in the southern part only (CALVO *et al.*, 1980, 1986). Though the surveys were carried out only during two seasonal periods the signs of a variation in the trophic condition in the northern part of the lagoon was noticed. Water outflows from the acquaculture plant, settled near the northern mouth at the beginning of the eighties, and the progressive burying of the mouth caused by southwards displacement of the Birgi creek mouth (RIGGIO *et al.*, 1983) seem to be the cause of the outspreading of dystrophic conditions which may endanger the Marsala lagoon ecosystems, particularly in the northern and central parts.

Tab. 1. Nutrients (µmol dm^{-3}) and chl *a* (µg dm^{-3}).

	Si(OH)4	NH3	NO3	NO2	Ntot	Chl a
MAY'91						
min.	0,60	0,21	0,04	0,02	2,33	0,01
max.	1,95	3,16	0,93	1,16	10,14	2,88
FEBRUARY '92						
min.	0,46	0,04	0,05	0,19	5,28	< 0,01
max.	3,70	4,38	94,25	2,39	17,15	2,10

Fig. 1. Surficial distribution of temperature, salinity, oxygen (% of saturation), chlorophyll a in February and May.



REFERENCES

CALVO, S., DRAGO D. and SORTINO M. 1980. Winter and summer submersed vegetation maps of the Stagnone. (Western coast of Sicily). *Revue de Biologie-Ecologie Méditerranéenne*, VII (2): 89-96.

CALVO S., GENCHI G., LUGARO A., FRADA ORESTANO C., BARONE R. and DI BERNARDO F.. 1986. Osservazioni ecologiche su una laguna siciliana (Lo stagnone, Trapani): nutrienti, clorofilla e parametri batteriologici. Atti del VII Congresso A.I.O.L., 185-194.

CEFALI A. and ANADALORO F. 1979. Considerazioni sulla distribuzione di alcune specie di poriferi nello Stagnone di Marsala. *Mem. Biol. Mar.Ocean.*, 9(1-2): 49-55.

CORRIERO, G. 1989. The sponge fauna from the stagnone di Marsala (Sicily): taxonomic and ecological observations. *Boll. Mus. Ist. Biol. Univ. Genova*, 53: 101-113,

RIGGIO, S., CALVO S., DI PISA G., GENCHI G., LUGARO A. and RAGONESE S. 1983. The Stagnone lagoon (Western Sicily): an ecological approach to the management of its natural resources. *Rapp. Comm. int. Mer Médit.*, 28(6): 143-146.

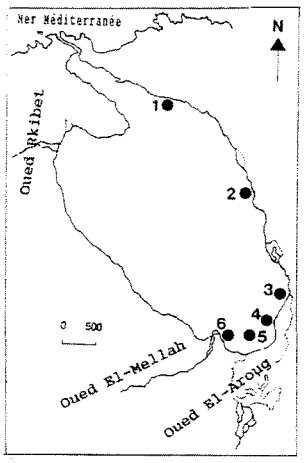
E

ÉVOLUTION SPATIO-TEMPORELLE DE LA BIOMASSE ET PRODUCTION MOYENNE DES POPULATIONS DE *CARDIUM GLAUCUM* (BRUGUIÈRE, 1789), *LORIPES LACTEUS* (LINNAEUS, 1758) ET *BRACHYDONTES MARIONI* (LOCARD, 1889) DU LAC MELLAH

GRIMES S.

Institut des Sciences de la Mer et de l'Aménagement du Littoral.
Laboratoire de Benthos, Alger, Algérie

L'étude dynamique des peuplements macrobenthiques du lac Mellah (extrême Est algérien) révèle l'importance de certaines espèces de bivalves, notamment les *Loripes lacteus, Cardium glaucum et Brachydontes marioni* dont les fluctuations sont en grande partie responsables de la physionomie du peuplement du lac. L'évaluation de leur production souligne l'importance de ces espèces ainsi que leurs contributions respectives dans la production secondaire globale de cet écosystème, comme elle permet de situer leur rôle dans le fonctionnement du lac. L'échantillonnage mensuel de mai 1991 à mai 1992 est réalisé à la main dans les limites d'un cadre portant sur une surface de 1/4 m^2 au niveau de six stations longeant les berges est et sud du lac, et réparties sur trois bancs de sable : le banc nord (station 1), le banc central (station 2) et le banc sud qui regroupe les stations 3, 4, 5 et 6 (carte ci-contre). Le tamisage est fait sur un tamis d'1 mm de côté. Les relations longueur-poids établies pour *L. lacteus*, *C. glaucum* et *B. marioni* permettent d'obtenir le poids moyen des individus. La biomasse (B) est exprimée en poids sec libre de cendres. La décomposition des structures de taille des populations de *L. lacteus*, *C. glaucum* et *B. marioni* est obtenue grâce au logiciel "NORMSEP" GROS et COCHARD (1978). La production (P) est estimée selon les méthodes de HYNES (1961) et de CRISP (1971). Les productivités (P/B) de ces trois populations de bivalves sont calculées. La biomasse présente de grandes fluctuations mensuelles. Les maximums sont notés en été pour *C. glaucum* et en hiver pour *B. marioni*. *L. lacteus* présente une biomasse qui reste élevée durant tout le cycle. Les plus fortes biomasses sont enregistrées en juillet à la station 4 : 23.14 g/m^2 chez *C. glaucum*, 41.46 g/m^2 en mars à la station 1 chez *L. lacteus* et 42.21 g/m^2 en février à la station 6 chez *B. marioni*. L'espèce leader est *L. lacteus* avec une biomasse mensuelle moyenne de 6.227 g/m^2 devant *B. marioni* (3.926 g/m^2) et *C. glaucum* (2.86 g/m^2). Du point de vue de la production de matière organique, le banc sud semble être le plus favorable : *C. glaucum* y est présent avec 3.903 g/m^2 soit près de 3.5 fois celle enregistrée au banc nord (1.075 g/m^2) et 5 fois celle calculée au banc central (0.798 g/m^2). *B. marioni* est présent au banc sud avec en moyenne 4.99 g/m^2, ce qui équivaut au double de celle estimée au banc nord (2.017 g/m^2) et le triple de celle évaluée au banc central (1.573 g/m^2). Pour *L. lacteus* , les biomasses mensuelles moyennes sont proches au niveau du banc nord (7.386 g/m^2) et au banc sud (5.236 g/m^2) et seulement 2.177 g/m^2 au banc central. L'estimation de la production par la méthode HYNES tient compte des longévités des espèces. L'évaluation de la durée de vie n'est pas toujours chose aisée. Dans le cas de *Cardium glaucum* du lac Ichckeul (Tunisie), elle est de 1 an (ZAOUALI, 1975), elle est de 2 à 3 ans au sud de l'Italie (IVELL, HYNES CRISP, 1979 a). Les données sur la longévité de *L. lacteus* et *B. marioni* ne sont pas disponibles. Dans ce travail, deux hypothèses de longévité sont retenues pour *C.glaucum* (12 et 14 mois) et trois pour *L. lacteus* et *B. marioni* (6, 8 et 12 mois). La méthode de HYNES donne des productions élevées : de 3.42 à 6.84 g/m^2/an pour la population de *L. lacteus*, de 1.59 à 3.09 g/m^2/an pour celle de *B. marioni* et de 1.58 à 2.37 g/m^2/an pour la population de *C. glaucum*. La méthode de CRISP semble surestimer la production : avec 9.74 g/m^2/an, *L. lacteus* est de loin la plus productive, suivie de *C. glaucum* (3.07 g/m^2/an) et de *B. marioni* (2.91 g/m^2/an) Les rapports P/B que permet de calculer la production calculée par la méthode de CRISP sont : 1.56 pour *L. lacteus*, 1.075 pour *C. glaucum* et 0.741 pour *B. marioni*. Les productions que donne la méthode de HYNES permettent d'estimer des productivités sensiblement voisines (tableau ci-contre). Les biomasses estimées aux trois bancs prospectés témoignent de la disponibilité d'une quantité importante de matière organique. Il reste à savoir dans quelle mesure cette richesse potentielle profite directement aux prédateurs et chemine le long de la chaîne trophique. La production moyenne de la population de *Cardium glaucum* est faible par rapport à celle estimée par IVELL (1979 b) sur les côtes anglaises (20.84 g/m^2/an). Les productivités obtenues sont inférieures à celles calculées par BAKALEM (1992) pour des bivalves de milieu marin (baie d'Alger). Enfin, une corrélation négative entre la longévité et la productivité est mise en évidence ainsi qu'une surestimation de la production par la méthode CRISP.



		HYNES	CRISP
L.lacteus	P	20.5 - 41.1	58.43
6-8-12mois	P/B	0.48-0.96	0.63
B.marioni	P	6.4-18.6	17.46
6-8-12mois	P/B	0.35 - 10.5	0.67
C.glaucum	P	9.5 - 14.2	18.45
12-14 mois	P/B	0.31-0.47	0.56

REFERENCES.

BAKALEM A., 1992.- Estimation et variation spatio-temporelles de la production de *Spisula subtruncata* (da Costa) (Mollusque bivalve) de la baie d'Alger. *Rapp. Comm. Int. Mer Médit.*, 33 : 28.

BAKALEM A., 1992.- Production de la population de *Venus gallina* (L.) (Mollusque bivalve) de la baie d'Alger. *Rapp. Comm. Int. Mer Médit.*,33 : 29.

CRISP D.J., 1971.- Energy flow measurement, in Holme and Mc Intyre (Eds.), Methods for the study of marine benthos. *IPB Handbook*, 16 : 197-279.

GROS PH. et COCHARD J.C., 1978.- Biologie de Nyctiphanes couchii (Crustacea, Euphausiacea) dans le secteur nord du golfe de Gascogne. *Ann. Inst. Océanogr. Paris*, 54 (1) : 25-46.

HYNES H.B.N., 1961.- The invertebrate fauna of a Welsh mountain stream. *Arch. Hydrobiol.*, 51 : 344-388.

IVELL R., 1979 a.- The biology and ecology of brackish lagoon bivalve, *Cerastoderma glaucum* in lago Lungo, Italy. *J. Moll. Stud.*, 56 : 229-238.

IVELL R., 1979 b.- The biology and ecology of brackish lagoon Bivalve, *Cerastoderma glaucum* in an english lagoon. The Warzwater in Sussex, 45 (4): 382-400.

ZAOUALI J., 1975.- Etude de la croissance de *Cerastoderma glaucum* Poiret: mer de Bou-Grara, Tunisie méridionale. *Rapp.Comm.Int.Mer Médit.*, 23: 77-78.

OBSERVATIONS ON THE MICROFLORA OF PADDY FIELDS (EBRO DELTA, SPAIN)

HERNÁNDEZ-MARINÉ M.[1] and PANKOW H.[2]

[1] Faculty of Pharmacy. University of Barcelona. 08028 Barcelona, Spain.
[2] Dep. of Botany, University of Rostock, Doberaner Str. 143, Rostock, Germany.

The Ebro Delta is an alluvial plain (350 km^2) situated in the northeast of the Iberian Peninsula. The area include coastal lagoons, a few marshes and paddy fields, that make up an important biotope (over 40%) with a very dense network of irrigation channels carrying Ebro river freshwater, from May to November. The water flowing out enters a series of lagoons which are also influenced by nearby sea water. In the paddy fields FORES & COMÍN (1986, 1987) studied the seasonal changes in phytoplankton, and in physical and chemical parametres, as well as the effect of the usual fertilization and biocide treatments on animal and plant populations. They found changes synchronized with agricultural treatments, but very few differences among different fields from year to year.

This study is based in field observations and samples collected from 1979 to 1990. Scraped soil surfaces and floating masses of algae coming from soils, lagoon edges and rice-fields were cultured (HERNÁNDEZ-MARINÉ, 1984). A quota of the sample was fixed in formalin solution. The temperature in water fluctuates from 12.0 to 36.2°C and conductivity from 0.44 to 2.40 mS.cm^{-1}.

Eighty-three taxa were recorded : 37 Cyanophyta, 26 Chlorophyta and 20 Bacillariophyta

CYANOPHYTA : *Anabaena cylindrica* Lemm., *Calothrix marchica* Lemm., *C. parietina* (Näg.) Thur., *Chroococcus minutus* (Kütz.) Näg., *C. turgidus* (Kütz.) Näg., *Cylindrospermum muscicola* Kütz., *Gloeocapsa polydermatica* Kütz., *Hydrocoleus lyngbyaceus* Kütz., *Lyngbya aestuarii* (Mert.) Liebm., *L. confervoidea Ag., L. hieronymusii* Lemm., *L. lagerheimii* (Möb.) Gom., *L. semiplena* (C.A.Ag.) *J.G.Ag. ex* Gom., *Microcoleus chthonoplastes* (Mert.) Thur. *ex* Gom., *Microcystis pulverea* (Wood) Forti, *Nodularia harveyana* Thur., *Nostoc ellipsosporum* (Desm.) Rabenh., *N. linckia* (Roth) Bornet *et* Flah., *N. punctiforme* (Kütz.) Hariot, *Oscillatoria bonnemaisonii* Crouan. *ex* Gom., *O. brevis* (Kütz.) Gom., *O. limosa* Ag. *ex* Gom., *O. nigro-viridis* Thwaites *ex* Gom., *Phormidium hypersalinum* Campbell *et* Golubi., *P. tenue* (Menegh.) Gom., *Plectonema nostocorum* Bornet *et* Thur. *ex* Gom., *Porphyrosiphon fuscus* Gom.*in* Fremy, *Pseudanabaena catenata* Lauterb., *Raphidiopsis curvata* Fritsch *et* Rich., *Spirulina maior* Kütz. *ex* Gom., *Sp. subsalsa* Oerst. *ex* Gom., *Sp. subtilissima* Kütz. *ex* Gom., *Tolypothrix byssoidea* (Hass.) Kirchn., *Xenococcus acervatus* Setch. *et* Gard., *X. kerneri* Hansg., *X. minimus* Geitler, *X. shousboei* Thur. *in* Bornet *et* Thur.

BACILLARIOPHYTA: *Cyclotella meneghiniana* Bréb., *Melosira granulata* (Ehr.) Ralfs, *Amphora ovalis* (Kütz.) Kûtz., *Bacillaria paradoxa* Gmel., *Cocconeis placentula* Ehr. *Cymatopleura elliptica* (Bréb.) W.Smith. *C. solea* (Bréb.) W.Smith, *Cymbella prostrata* (Berk.) *Cl., Diatoma vulgare* Bory, *Gomphonema constrictum* var *capitata* (Ehr.) *Cl., Gyrosigma attenuatum* (Kütz.) Rabenh., *Hantzschia amphioxys* (Ehr.) Grun., *Navicula cryptocephala* var *veneta* (Kütz.) Grun., *Navicula tripunctata* (O.F.Müll.) Bory, *Nitzschia acicularis* W.Smith, *N. acicularis* var *closterioides* Grun., *N. sigmoidea* (Ehr.) W.Smith, *Roicosphenia abbreviata* (Ag.) Lange-Bert., *Synedra ulna* (Nitzsch) Ehr., *Surirella ovalis* Bréb.

CHLOROPHYTA *: Bracteacoccus minor* (Chod.) Petr., *Chlorella vulgaris* Beij., *Chlorococcum* ssp., *Chlorokybus atmophyticus* Geitler, *Chlorolobion braunii* (Näg.) Kom., *Coelastrum microporum* Näg., *Crucigeniella apiculata (Lemm.)* Kom., *Dictyosphaerium pulchellum* Wood, *Excentrosphaera viridis* G.T.Moore, *Gongrosira scourfieldii* G.S.West, *G. papuasica* (Borzi) Tupa, *Monoraphidium contortum* (Thur.) Kom.-Legn., *Neochloris terrestris* Herndon, *Pediastrum duplex* Meyen, *P. tetras* (Ehr.) Ralfs, *Pleurastrum insigne* Chod., *Scenedesmus armatus* Chod., *S. caudato-aculeatus* Chod. *S. intermedius* Chod., *S. quadrispina* Chod., *Schroederia setigera* (Schröd.) Lemm., *Tetraâdron minimum* (A.Br.) Hansg., *Chaetophora elegans* (Roth) Ag., *Oedogonium sp., Pithophora oedogonia* (Mont.) Wittr. var *polyspora* Rendle, *Rhizoclonium hieroglyphicum* (A.Ag.) Kütz.

The algal vegetation was neither rich in quality nor abundant. For every field conditions (soil, lagoon edges or rice-fields) the algal species grown in culture remained quite similar all year round and during the study years. In the paddy fields the occurrence of mats was irregular and restricted to the end of the summer period before harvesting and drying up, when no more biocides were applied. On the wet margins *Lyngbya aestuarii* and *Phormidium tenue* were the most common forms. *Microcoleus chthonoplastes*, although present, was never the main forming organism. The community was dominated by the Oscillatoriaceae and although all of them have been reported for similar habitats, the dominant species are not the same as those reported from other paddy fields (ANAGNOSTIDIS *et al*, 1981, LIU & LI, 1989). Among the blue green algae, 35% of the total taxa were heterocystous. The scarcity of diatoms and the exclusion of algal groups other than blue-green and green algae might be related to the negative effects of herbicide and pesticide applications (VENKATARAMAN & RAJYALAKSHMI, 1971, FORES & COMÍN, 1987) or inhibition due to added N fertilizer (SINGH & BISOYI, 1989), although the nutrient input seems to favor phytoplankton growth in the fields (FORES & COMÍN, 1986). A larger number of forms were common to soils, lagoon edges and rice-fields. However, cultures from bare soils display a larger species number than those from paddy field soils (HERNÁNDEZ-MARINé, 1984). In this case, resistant forms from soils and mats near the lagoons can lead to reestablishement in the paddy fields after ploughing (LIU & LI, 1989).

REFERENCES

ANAGNOSTIDIS, K., ECONOMOU-AMILLI, A. & TSANGRIDIS, A., 1981.- Taxonomic and Floristic Studies on Algae from rice-Fields of Kalachorion-Thessaloniki, Greece. *Nova Hedwigia*, 35: 1- 66.

FORÉS, E. & COMÍN, F.A., 1986.- Características limnologicas de los arrozales del Delta del Ebro (NE España). Oecologia aquatica, 8: 39-45.

FORÉS, E. & COMÍN, F.A., 1987.- Efecto de los tratamientos químicos agricolas sobre algunas características limnologicas de los arrozales. *Limnética*, 3: 17-23.

HERNÁNDEZ-MARINÉ, M.C., 1984. Algas edàficas (Delta del rio Ebro). *Anales de Biología*, 2: 119-125.

LIU, Y. & LI, S. (S.H.LEY), 1989.- Species composition and vertical distribution of blue-green algae in rice soils, Hubei, China. *Nova Hedwigia*, 48: 55-67.

SINGH, P.K. & BISOYI, R.N., 1989.- Blue-green algae in rice fields. *Phykos*, 28: 181-195.

VENKATARAMAN, G.S. & RAJYALAKSHMI., 1971.- Tolerance of bluegreen algae to pesticides. *Curr. Sci.*, 40: 143-144.

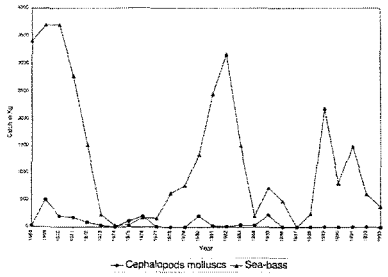
THE COASTAL LAGOON OF FUSARO (NAPLES, ITALY), SOME ECOLOGICAL ASPECTS AND FISHERY PRODUCTION

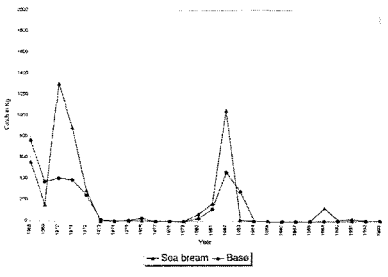
IANNIBELLI M. and LEVI D.

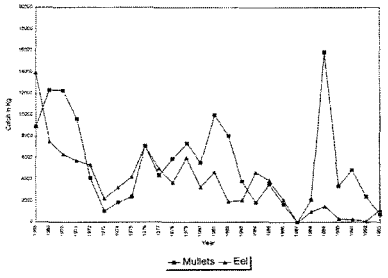
Istituto di Tecnologia della Pesca e del Pescato. C.N.R. Mazara del Vallo. Italy

Fusaro Lake, the ancient "Palus Acherusia" is a brackish lagoon located on the Tyrrhenian shore (20 km North of Naples). It was formed, most probably, following a secondary volcanic phenomenon belonging to the sulfataric type, which brought to a geological structure of a circular form, originally bigger than the present one, reduced to the present trapezoidal form by a great dune that now separates the lake from the sea and that surely can be considered of marine origin (LECCESE and SPEZIALE, 1967). The surface of this lake is about 969.120 m^2 (LECCESE and SPEZIALE, 1967) and it communicates with the sea by means of 3 mouths, that can be considered the key for the equilibrium of the entire lagoon, a typical characteristic of the coastal brackish lagoon (CARRADA, 1973). The maximum, minimum and mean depths are respectively 6 m, 1.10 m and 3.065 m. The extreme temperatures can reach 28-30° C at the maximum and values of a few degrees at the minimum, however the annual mean is 20-21° C (LECCESE and SPEZIALE, 1967). As to salinity it can be evidenced that extreme values have been reported (32.8% - 41.5%) but the average maximum and minimum salinities are 35.5% and 37.9% (MAGAZZU' and PANELLA, 1969). As to dissolved oxygen there is a considerable evidence of high winter and spring concentrations (CARRADA, 1973). However, although values are high in the bottom areas rich of phytobenthos, in the deepest waters concentrations below the level of saturation are observed for the greater part of the year (MAGAZZU' and PANELLA, 1969). In the spring-summer period the formation of a partially or totally deoxygenated thicker zone at the lake bottom could be observed (MAGAZZU' and PANELLA, 1969). The considerable presence of nutrients, mainly inorganic phosphates (MAGAZZU' and PANELLA, 1969) induces to agree wholly with MONTALENTI (1967) who indicated a great pollution in the lagoon and with LECCESE and SPEZIALE (1967) who denounced the irresponsible human activities that have brought the mentioned lagoon to the actual conditions. Notwithstanding this difficult situation the fishing of Cephalopods Molluscs and Teleosteans is still practiced successfully in Lake Fusaro, while that of bivalve Molluscs has been totally abandoned, regardless the existence of the well-known local tradition and the considerable scientific contributions relative to the ecology and management of this lagoon (RENZONI and SACCHI, 1961; SACCHI and RENZONI, 1962).

The fishery statistic data, gathered by the Centre Ittico Tarantino Campano, which manages the lake and entrusts to an external cooperative society its fishing exploitation, is analyzed in a preliminary manner. Data of 25 years, from 1968 to 1993, have been registered dividing the catches in: sea bass, gilt-head sea bream, red-mullet, base, annular sea bream, mullet, sel, cuttle-fish and octopus. The fishing gears used are fundamentally trammel-nets, winged fyke-nets and fishing-lines. In the month of December, special winged fyke-nets are used, placed in the central sea-communication channel. Regarding the sea bass (*Dicentrarchus labrax* (L.)) and the sea bream (*Sparus aurata* L.) it can be evidenced a contemporary maximum of capture in 1970, with 3701 kg. and 1309.2 kg. respectively. Red-mullets (*Mullus barbatus* L.) were captured only in 1975, for a total of 2.75 kg. Regarding base (*Diplodus sargus L., Diplodus vulgaris* (E. Geoffr.) and *Diplodus puntazzo* (Gm.)) it is evidenced the height of capture (461.8 kg.) in 1982, year in which a notable presence of sea bass (3171.1 kg.) and mullets (1052.35 kg.) were registered. The production of mullets (*Mugil cephalus L., Liza ramada* (Risso), *Liza aurata* (Risso), *Liza saliens* (Risso) and Chelon *labrosus* (Risso) reached a considerable level (15855.2 kg.) in 1969 while the sels (*Anguilla anguilla L.*) reached the pro-duction of 7562.95 kg. During the same year, 503 kg. of cuttle-fishes (*Sepia officinalis* L.) and octopusses (*Octopus vulgaris* Lamk.) were caught. Lastly, the presence of salema (*Sarpa salpa L.*) and shrimps (*Palaemon* and *Palaemonetes*) is evidenced for a total of 16 kg. It is evident from a first analysis that Fusaro fisheries are rich in commercially valued species, mainly sea bream and sea bass representing about 20% of the total catch, as also observed in a general study on aquacolture in Campania (DALLA ROSA, 1984). In 1982, the marked production of sparoids leads us to hope in a total recovery of the lagoon, if there is a rapid intervention. The great presence of sparoids, as it is well-known, indicates a low trofic level. However, the most important production is that of mullets and eels that are present in great abundance mainly in the lagoon post-dystrophic period. In conclusion, it is out of any doubt that with correct management Lake Fusaro could be one of the most productive Tyrrhenian lagoons in terms of fishing industry.







REFERENCES

CARRADA G.C., 1973. Profilo ecologico di una laguna salmastra flegrea: il lago Fusaro. *Archo Oceanogr. Limnol.*, 18 supp.: 145-164

DALLA ROSA L., 1984. Potenzialità e risorse dell'acquacoltura nella regione Campania. Experimental thesis in Aquacolture (P.Melotti) Univ. of Bologna

LECCESE A. and SPEZIALE V., 1967. I laghi Fusaro e Miseno e l'inquinamento delle loro acque. Centro Ittico Tarantino Campano. Ionica editrice : 82 pp.

MAGAZZU' and PANELLA S. 1969. Ciclo di osservazioni chimico-fisiche nel lago del Fusaro. *Boll. Pesca Piscic. Idrobiol.*, 24 : 171-183

MONTALENTI G., 1967. Relazione sulla protezione delle lagune e degli stagni costieri della Penisola e delle Grandi Isole. Quaderni de *La Ricerca Scientifica* C.N.R., 38 : 48 pp.

RENZONI A. & SACCHI C.F., 1960. Notes sur l'écologie de la moule (*M. galloprovincialis* Lam.) dans le lac Fusaro (Naples). *Rapp. Proc. verb. CIESM.*, 16 : 811-814.

SACCHI C.F. & RENZONI A., 1962. L'écologie de *M. galloprovincialis* (Lam.) dans l'étang littoral du Fusaro et les rythmes annuels et nychtéméraux des facteurs environnants. *Pubbl. Staz. Zool.* Napoli, 32 (sup.) : 255-293.

ETAT DES CONNAISSANCES SUR LA BIODIVERSITÉ (FAUNE BENTHIQUE) D'UNE LAGUNE MEDITERRANÉENNE : LAGUNE DE NADOR (MAROC)

Mohamed MENIOUI[1] et Nasser Eddine ZINE[2]

[1] I S, BP. 703, Rabat-Agdal et CNR B.P.8027, Rabat, Maroc

[2] Faculté des Sciences, B.P. 4010, Beni M'Hammed, Meknès, Maroc

Malgré sa grande superficie (115 km^2) et son intérêt écologique, scientifique et économique, la lagune de Nador (35°7'N à 35°16'N, 2°44' W à 2°60'W) est restée longtemps ignorée. Les 174 échantillons des 14 stations (fig.1) ont fourni 296 espèces et 10 groupes zoologiques. La figure 1 montre une très nette dominance des mollusques (Mol., 180 espèces, soit 60% du total de la faune), des crustacés (Cru., 51 espèces), puis des polychètes (Ann.,41 espèces). Ces trois groupes, dominants aussi dans la majorité des peuplements superficiels, représentent plus de 92% du total des espèces.

Mollusques : SAUBADE (1979) en rapporte 58 espèces auxquelles s'ajoutent postérieurement d'autres espèces (ZINE et MENIOUI, 1992). Cette lagune compte actuellement 180 espèces de mollusques (141 formes vivantes et 39 rencontrées seulement à l'état de coquilles vides). La figure 2 montre que les Gastéropodes (Gas) sont dominants (99 espèces, 55% du total de ce groupe), suivis des Lamellibranches (Lam) représentés par 75 espèces (41%). Les Polyplacophores (Pol), les Scaphopodes (Sca) et les Céphalopodes (Cep) n'excèdent pas 4% du total de ce groupe. Quantitativement, les mollusques sont nettement dominés par *Corbula gibba, Loripes lacteus* et *Loripes fragilis* dans les stations où prédominent les substrats meubles, surtout vaseux, avec deux gisements naturels de palourdes (*Venerupis decussata*), à proximité de la bordure continentale, et de nacres (*Pinna nobilis*), non loin de la passe. Les espèces *Bittium reticulatum et Cerithium rupestre* sont assez abondantes dans la quasi-totalité des stations, alors que dans celles où les substrats durs abondent, il y a une nette dominance des Mytilidés (*Mytilus et Modiolus*).

Crustacés : Les crustacés benthiques, peu étudiés dans ce milieu, paraissent relativement peu diversifiés. Les 51 espèces sont réparties sur 6 taxa (fig. 3) : amphipodes (20 espèces, soit 39,21%), ostracodes (14 espèces, soit 27,45%), isopodes (10 espèces, 19,60%), tanaidacés et décapodes (3 espèces chacun; 5,8%) et cumacés (1 espèce; 1,9%). Dans la bordure continentale où dominent les substrats rocheux, les crustacés ont été les mieux étudiés; on y trouve une très nette dominance des ostracodes (surtout *Aurila et Xestoleberis*), des amphipodes (*Corophium insidiosum, Elasmopus rapax, Gammarus insensibilis* et *Erichtonius brasiliensis*) et des Tanaidacés (*Tanais dulongii* et *Leptochelia dubia*). Au milieu de la lagune et aux extrémités nord-ouest et sud-est se sont pratiquement les mêmes espèces qui dominent avec, cependant, une très nette diminution de l'abondance des tanaidacés et l'apparition de *Cymodoce emarginata, Idotea baltica* ainsi que certaines *Aoridea* dont *Microdeutopus*.

Polychètes : Les 41 espèces de polychètes représentent environ 14% du total des espèces recensées. Les espèces dominantes dans les stations rocheuses sont des formes à très large répartition écologique dont *Platynereis dumerilii, Syllis prolifera* et *Theostoma oerstedi* auxquelles s'ajoutent des espèces psammophiles dont *Cirriformia tentaculata*, indicatrice de pollution. La présence de cette dernière dans ces stations, surtout sur la bordure continentale, s'explique aisément par le dépôt de sédiments et de matières organiques qui recouvrent le substrat. Cette espèce est, de plus, dominante dans les stations meubles du centre de la lagune et dans les herbiers où elle est accompagnée le plus souvent par *Glycera convoluta et Lumbriconereis impatiens*.

Quant aux autres groupes zoologiques (fig.4), ils sont qualitativement dominés par les foraminifères (For.), essentiellement psammophiles (16 espèces), suivis des Echinodermes (Ech., 4 esp.), puis des spongiaires (Spon.), des pycnogonides (Pyc.) et des halacariens (Aca.) (2 esp. chacun) et enfin les cnidaires (Cni.) et des larves d'insectes chironomides (Ins.) (1 esp. chacun). Sur le plan écologique, l'analyse faunistique du peuplement benthique de la lagune de Nador est essentiellement constituée par des espèces euryèces, supportant, par conséquent, de grandes variations des facteurs physico-chimiques. La lagune de Nador peut être considérée comme la plus diversifiée de toutes les lagunes marocaines. Elle peut être également considérée parmi les moins productives à l'échelle de la Méditerranée. Aussi, malgré la diversité du peuplement benthique, le confinement progressif à l'intérieur de ce milieu se manifeste par un appauvrissement des peuplements. Pour les mollusques, par exemple, qui sont les plus abondants et les mieux étudiés, 110 espèces ont été identifiées en 1983 dans trois stations seulement, alors que nos analyses plus récentes sur 174 échantillons répartis dans 14 stations, ne nous ont permis d'identifier que 88 espèces. Le peuplement benthique de la lagune de Nador, de par sa structure, semble indiquer que ce milieu est en train de subir de profondes transformations, malheureusement, régressives

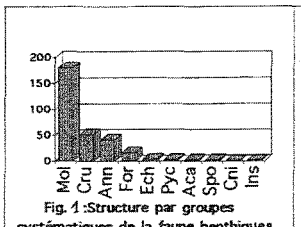


Fig. 1 :Structure par groupes systématiques de la faune benthiques

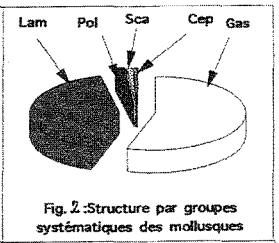


Fig. 2 :Structure par groupes systématiques des mollusques

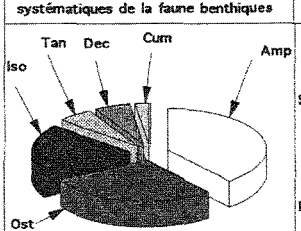


Fig. 3 : Structure par groupes systématiques des crustacés

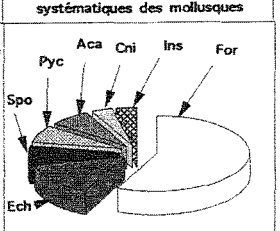


Fig. 4: Structure par groupes systématiques des "Divers"

REFERENCES

SAUBADE A.M. 1979 - La malacofaune actuelle de la lagune de Nador. *Bull. Inst. géol. Bassin Aquitaine*, 26: 69-81.

ZINE N.E. et MENIOUI M. 1992 - Le peuplement malacologique de la lagune méditerranéenne de Nador (Maroc): Etat des connaissances. *Marine Life*. 2(1): 39-45.

DIATOMS IN HYPERSALINE SOLAR SALTERN PONDS (EBRO DELTA, SPAIN)

MERINO V.[1], CLAVERO E.[2], GRIMALT J.O.[2] & HERNÁNDEZ-MARINÊ M.[1]

[1] Lab. of Botany. Fac. of Pharmacy. Univ. of Barcelona. Av. Joan XXIII, s/n.
[2] Dept. of Environmental Chemistry (CID-CSIC). C/Jordi Girona, 18. 08034 Barcelona. Spain.

Benthic diatoms constitute an important component of the microbial mats developed in the lower range of salinities in hypersaline environments, although few studies on diatom communities in such environments have been published to date (EHRLICH & DOR, 1985, NOËL, 1984). This paper presents the diatoms that thrive in the solar saltern ponds "La Trinitat" and their distribution as function of salinity.

In these salt fields (Ebro delta, 40°35'N, 0°40'E, South Catalonia, Spain) halite is obtained by pumping sea water to an array of evaporation ponds. The water flows through this system, and evaporates and increases in salinity through successive ponds. The salt concentration within each pond changes only slightly owing to human control, hence communities of each lagoon develop in a high but constant salinities. After the halita is harvested, from August through November, the pools are once again flooded with sea water.

Diatoms appear in the first three ponds of the circuit, with salinity ranging from that of sea water to 120‰. In these ponds (called Deposits 0, 1 and 2), sedimentation of sand and organic matter and carbonate precipitation occurs (CLAVERO *et al.*, this volume). Samples for optical, SEM and TEM examination and measurements of physical and chemical parametres were obtained monthly in 1994. When possible, depending on the presence and abundance of photosynthetic organisms, the sediment was sampled by taking cores. These cores were sliced in roughly 1 mm-thick sections, corresponding to the sediment layers.

In the lowest salinity pond, Deposit 0 (mean salinity 48‰), either the floor was nude or the organisms did not produce layers. Under the shallow water, *Ruppia maritima, Chaetomorpha* sp. and *Cladophora* sp. developed in spots. Some diatom species, e.g., *Striatella unipunctata* (Lyngbye) Agardh, *Achnantes brevipes* Agardh, *Cocconeis placentula* var *euglypta* (Ehr.) Cleve, appeared in high quantities among the macrophytes or epyphiting them. Surrounding the pond, in spring, there is a temporarily flooded ring with a water covering of only few mm, in which a distinct laminated mat of filamentous cyanophytes develops with a golden-brown upper layer built by diatoms. This community was dominanted by species of the genera *Amphora, Navicula* and *Nitzschia : Nitzschia lembiformis* Meister, *Nitzschia sigma* (Kütz.) W. Smith and *Nitzschia vidovichii* (Grun.) Peragallo. As summer went on the marginal ring dried up with a leathery appearence.

In Deposit 1 (mean salinity 64‰) the most abundant diatom was *Pleurosigma elongatum* W. Smith, which appeared abundantly on the surface sediment, associated with filaments of cyanophyta. It also appeared on sporadically wet sediments and forming floating lumps together with *Lyngbya aestuarii* Liebm. Other diatoms that also appeared in abundance were *Scoliopleura tumida* (Brev.) Rabenhorst and some species of *Navicula* and *Amphora : A. coffeaeformis* (Agardh) Kützing, *A. acutiuscula* Hustedt, *A. hyalina* Kützing. *Cocconeis placentula* var *euglypta, Pleurosigma elongatum* and *Nitzschia sigma* were also observed associated with *Cladophora* sp. In summer, the partially flooded borders developed a green and white mass of *Beggiatoa* sp. and L. *aestuarii* mixed with living *Surirella striatula* Turpin and *Pleurosigma elongatum*.

In Deposit 2 (mean salinity 97‰) the number of species and individuals was smaller. The most abundant was *Nitzschia lembiformis* (which also appeared in Deposit 1, but less frequently). *Surirella striatula, Amphora coffeaeformis, Nitzschia frustulum* (Kützing) Grunow and *Nitzschia sigma* were also well represented.

Heaters (subsequent ponds with salinities over 120‰) were devoid of diatoms, except for empty valves and girdle bands of *Nitzschia* sp., probably allochtonous.

Some of the taxa found in the least saline pond (Deposit 0) are known from the nearby marine waters, e.g., *Striatella unipunctata, Surirella fastuosa* (Ehr.) Kützing, and *Achnantes brevipes*, and were not observed in ponds of higher salinities. Others, like *Nitzschia vidovichii, Pleurosigma elongatum* and *Gyrosigma spencerii* (Quek.) Grif. et Henfr., occurred only in waters with 44-80‰. *S. Nitzschia lembiformis* was found only with salinities from 53‰ to 150‰ predominantly in the hypersaline pond Deposit 2 (85-105‰ S). The salinity range gives this species an "hyperhalobius" character (EHRLICH & DOR, 1985). Most of the diatoms recorded were euryhaline, but their halotolerance varied. A general decrease of diatom diversity in increasing salinity was found. Some species dissapeared at lower salinities, while several species were present throughout the entire area at salinities of 44-115‰, e.g., *Amphora angusta* (Gregory) Cleve, *A. coffeaeformis, Nitzschia frustulum* and *Nitzschia sigma*, in accordance with their classification as euryhaline forms (EHRLICH & DOR, 1985, NOËL, 1984).

A remarkable fact is that no frustules of central diatoms were found in sediments, which points out that in these shallow saline waters central diatoms did not develop, which agrees with previous results (NOËL, 1984).

REFERENCES

EHRLICH A. & DOR I., 1985.- Photosynthetic microorganisms of the Gavish Sabkha. In: Friedman & Krumbein (eds.) Hypersaline Ecosystems. The Gavish Sabkhain : 296-321.

CLAVERO, E., MERINO, V., GRIMALT, J.O. & HERNÁNDEZ-MARINÉ, M., 1995.- Cyanophyta in hypersaline solar saltern ponds (Ebro Delta, Spain). *Rapp. Comm. int. Mer Medit.*, this volume.

NOËL D., 1984.- Les diatomées des saumures et des sédiments de surface du Salin de Bras del Port (Santa Pola, province d'Alicante, Espagne). *Revista d'Investigacions Geologiques*, 38/39 : 79-107.

ZOOPLANKTON TEMPORAL VARIATION IN A SPRING-POOL OF THE ALBUFERA NATURAL PARK

Maria R. MIRACLE, M. Teresa ALFONSO and Eduardo VICENTE

Departament d'Ecologia i Microbiologia. Facultat de Ciències Biològiques. Universitat de València. 46100 Burjassot (València). Espana

The aquatic ecosystems of the Albufera Natural Park have been subject to intense human impact. They consist mainly in a large lagoon of 23 km^2, surrounded by 223 km^2 of rice fields. However, there are still a number of spring-pools, i.e. small and shallow pools fed by subterranean water inflow, which are less polluted and could be regarded as refuge areas for rare species. The succession of zooplanktonic populations has been studied during two annual cycles in the most well kept of these spring-pools : "Baldovina", by means of monthly quantitative water samples taken with a 2.6 l Ruttner bottle and filtering by a 45 µm mesh. Physical and chemical parameters of the spring waters should be rather constant, but they are influenced by rice field water which occasionally drain into the spring-pool in early summer. When this occurs, a rise in temperature and a diminution of conductivity can be observed in the pool (Fig.1C). Rice field influence varies from one year to another; in 1986 the perturbation was restricted to June and the beginning of July, while in 1987 the pool was perturbed during a much longer period. The water from the rice field is loaded with fertilisers and pesticides which impoverishes faunal composition and the effects on the zooplankton community are very apparent. We can easily observe drastic differences between the two years in Fig.1. During the more perturbed year cladocerans were not observed and the number of species of copepods diminished and changed to more opportunist ones (Fig.1B). Moreover, zooplankton succession in 1986 (rotifers and crustaceans) was as expected from the theoretical point of view (Fig.1A), i.e. a biomass peak in spring is followed by a later increase of diversity in summer. However, during the more perturbed year 1987, this cycle was interrupted, so a high development of biomass in summer occurred, which determined a reduction of diversity. Therefore, diversity did not increase until September, at the end of rice culture.

The richness of species in this biotope is very high; beside the crustaceans of Fig.1, we have found 95 species of rotifers. Moreover, a single net tow sample in the littoral zone can yield a Shannon diversity index, for rotifer fauna, as high as 4.6. Previous studies in this and other spring-pools (COLOM and MIRACLE, 1990; ALFONSO and MIRACLE, 1987) also showed that plankton communities are subject to wide fluctuations, however they still keep a very high diversity. The total number of species found, until now, in the plankton in four of these spring-pools is : 107 rotifer species, 6 cladocerans and 13 copepods.

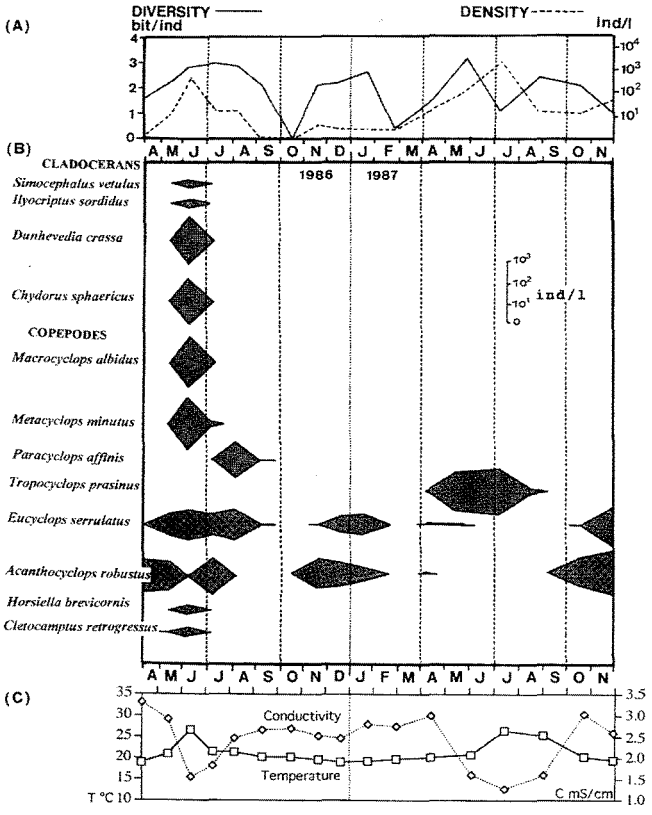


Fig.1. Temporal variation in Baldovina spring-pool of: (A) zooplankton (crustaceans and rotifers) density (ind/l) and diversity, (B) abundance of crustacean species (ind/l) and (C) temperature and conductivity.

REFERENCES

ALFONSO, M.T. and MIRACLE, M. R., 1987. Estudio comparativo del zooplancton en tres ullales del Parque Natural de la Albufera de Valencia. *Limnetica*, 3 (2): 263-272.

COLOM, W. and MIRACLE, M. R., 1990. Cycle annuel du Phytoplancton en deux sources du Parc Naturel de "L´Albufera de Valencia" (Espagne). *Rapp. Comm. int. Mer Médit.*, 32 (1): 71.

ZOOCÉNOSES AQUATIQUES DANS TROIS ÉTANGS DE LA SARDAIGNE CENTRALE (SAL'E PORCUS, SALINA MANNA, SA MARIGOSA)

M. A. DE MIRANDA RESTIVO, L. DURANTE, E. SERRA

Département de Biologie Animale et d'Ecologie, Université de Cagliari, Italie

Les zones humides dans la péninsule du Sinis sont très nombreuses. Nous avons étudié les biocénoses aquatiques de Sal'e Porcus, Salina Manna et Sa Marigosa. Les deux premiers sont des milieux astatiques, alors que Sa Marigosa est un étang rétrodunal; tous ces milieux ont une grande importance écologique. Les échantillonnages ont été effectués mensuellement lorsqu'il y avait de l'eau pour les deux premiers tandis que à Sa Marigosa nous les avons effectués régulièrement pendant toute l'année. Nous avons enregistré la température de l'eau, le pourcentage de saturation de l'oxygène dissout, la salinité et la chlorophylle comme évaluation de biomasse. Enfin, nous avons filtré, avec un filet de 60 µm de maille, une quantité connue d'eau pour déterminer le zooplancton.

SAL'E PORCUS. C'est la plus grande zone humide située dans la partie septentrionale de la péninsule du Sinis; elle présente les caractéristiques morphométriques suivantes : une profondeur maximum de 30 cm et une superficie de 350 ha. Elle n'a pas d'affluents et se trouve à environ un km de la mer. Puisque son substrat argileux et imperméable ne permet pas aux eaux de suinter, il y a une cristallisation des sels indissolubles (MASSOLI NOVELLI et MOCCI DEMARTIS, 1989). Les terrains environnants présentent une végétation typique haloéphile où domine *Salicornia frutticosa L.*. Parmi les limicoles hivernantes, on trouve aussi *Recurvirostra avosetta L.* (MASSOLI NOVELLI et MOCCI DEMARTIS, 1989). Ce milieu a été déclaré oasis de protection faunistique depuis 1980. Les taxa retrouvés sont : *Copepoda* avec une seule espèce *Paronychocampus nanus Sars*, et *Ostracoda* avec *Eucypris calaritana*. Concernant la richesse en taxa, nous avons relevé une différence entre nos données de densité et ce que SERRA a enregistré en 1977. Quant à la biomasse phytoplanctonique, elle est aussi très modeste.

SALINA MANNA. Ses caractéristiques morphométriques sont une profondeur maximum de 0.6 m et une superficie de 65 ha. Son substrat est argileux et imperméable. La flore autour de l'étang est représentée par *Juncus sp.* et *Salicornia sp.*. La faune ornithologique est riche en Limicoles. On trouve aussi aussi *Phoenicopterus ruber L.*. Les taxa retrouvés sont : *Phyllopoda* avec *Artemia salina L.*,*Copepoda* avec *Paronychocampus nanus* Sars, *Rotatoria* avec *Albertia typhylina* Har et Myer, *Ostracoda* avec *Cyprideis littoralis* Brady.

SA MARIGOSA. Ses caractéristiques morphométriques sont une profondeur maximum de 0.5 mt et une superficie de 25 ha. Son fond marin est constitué de boue et de sable. La végétation des rives est composée de rares salicornes; *Enteromorpha* sp. constitue au contraire la flore submergée. Pour la faune ornithologique, l'espèce dominante est *Recurvirostra avocetta L.* Il y a aussi *Phyllopoda, Ostracoda, Copepoda, Rotatoria* et *Nemaétoda* , les mêmes espèces que celles trouvées à Salina Manna. Les peuplements sont plus nombreux par rapport à ceux trouvés dans les milieux astatiques sus-mentionnés.

Nous avons prélevé des quantités données de substrat. Puis en laboratoire, nous avons recréé les conditions naturelles du milieu pour déterminer l'existence de formes de résistance présentes dans le substrat de Sal'e Porcus et Salina Manna. Nous avons enregistré l'éclosion de, dans l'ordre, *Cilioéphora, Microphlagellata, Diatomeae, Cyanophiceae, Nematoda, Ostracoda, Phyllopoda (larvae).*

REFERENCES

MASSOLI NOVELLI R., MOCCI DEMARTIS A.-1989- Zone umide della eSardegna. *Olimpia* éd. Firenze : 97-100

DE MIRANDA M.A, A. MOCCI DEMARTIS, E.SERRA -1988- Etude qualitative et quantitative des biocénoses aquatiques dans quelques milieux humides de la Sardaigne Occidentale. Time Scales and Water Stress- Proc. 5th Int. Conf. on Medit. écosystems.

SERRA E. -1977- Modificazioni biocenotiche in stagni continentali sardi a seguito dell'interruzione e successuva ricomparsa dell'astaticità. Rend. Sem. Fac. Sc. Univ. Cagliari, XLVII, 1-2 : 127-146.

RÔLE DE LA SALINITÉ ET DES PERCHOIRS DANS LE CHOIX DES ENDROITS D'HIVERNAGE DU GRAND CORMORAN (*PHALACROCORAX CARBO SINENSIS*)

Attilio MOCCI DEMARTIS

Département de biologie animale et d'écologie. Université de Cagliari. Italie

Aujourd'hui, alors que la population hivernante du Grand cormoran (*Phalacrocorax carbo sinensis)* augmente dans de nombreuses régions d'Italie (BACCETTI, 1988), l'ornithologie doit s'interroger sur les causes de cette augmentation, sur la dispersion géographique hivernale de l'espèce et sur les méthodes les plus favorables à contenir le préjudice, présumé ou vrai, que l'espèce causerait à l'économie de la pêche. Pour résoudre ce problème, je vais examiner dans cette note la relation entre la densité de la population sarde et quelques caractéristiques du milieu.

Grâce aux recensements menés dans 16 étangs de la Sardaigne, centro-occidentale et méridionale, pendant 20 hivers consécutifs (1975-1994) (MOCCI DEMARTIS, in press), on peut affirmer qu'il y a eu une augmentation continue de la population sarde. Cependant, le tableau 1 ne prend en considération que les moyennes hivernales des dix dernières années. En utilisant les valeurs moyennes de salinité, analysé par moi en même temps que les recensements, on peut classer ces 16 étangs en quatre catégories, selon le schéma de SACCHI (1980) : les eaux ipoalines (0,5 - 5%), mésoalines (5 - 18%), polialines (18 - 37%) et iperalines (37% et plus). Par la combinaison de la salinité des étangs, ordonnés de cette manière, avec les moyennes hivernales de cormorans, on voit que cette espèce préfère stationner dans les eaux polialines ayant des valeurs moyennes de 32 - 37%, comme dans les étangs de S. Giusta (Oristano) et de S. Gilla (Cagliari). Quant au préjudice causé à la pêche, si auparavant dans ces étangs il y avait une pêche florissante, aujourd'hui elle s'est réduite seulement pour des causes indépendantes des cormorans. En effet, ces étangs sont malheureusement très pollués par des substances organiques et agricoles (S. Giusta), ou industrielles (S. Gilla).

Naturellement le Grand cormoran n'est pas tant sensible à la salinité des étangs en elle-même qu'à la présence de poissons. En effet, on trouve dans les eaux saumâtres une plus grande variété qualitative d'espèces de poissons et quantitative d'individus.

Un autre facteur recherché par le Grand cormoran est la présence de supports levés et isolés, utilisés par l'espèce comme dortoirs (roost), plus ou moins proches des endroits de pêche (feeding grounds). Selon la littérature (BACCETTI, 1988) il y a une grande diversité de ces supports, tels que : a) vieux arbres hauts de 20 m. environ, disposés près des rivages ou émergeant de l'eau, b) poteaux pour les moules, c) bidons flottants, d) terminales d'oloducs, e) digues foraines, f) vieilles constructions semi-submergées. Toujours en Sardaigne, on trouve d'autres exemples: 1) lignes électriques (dans l'étang de Molentargius : MOCCI DEMARTIS, 1992), 2) promontoires marins gagnés par les cormorans traversant la mer (Capo S. Marco : MOCCI DEMARTIS, inédit), 3) petites îles (étang de S. Teodoro, inédit).

En conclusion, lorsqu'il existe dans les étangs ces deux facteurs, l'arrivée de l'espèce est très probable. Elle peut être chassée par l'homme au moyen d'appareils de dissuasion, ou déroutée vers des milieux humides proches à repeupler avec des poissons peu appréciés. Toute essai d'abattage, contraire aux directives européennes, ne constituerait qu'un palliatif temporaire.

Tableau 1 : Classification des étangs selon leur salinité (SACCHI, 1980) et présences annuelles moyennes des cormorans.

Categ.	Etangs	Salinité	'84	'85	'86	'87	'88	'89	'90	'91	'92	'93	'94	Moyenne
IPO..	Cabras	2,5 ‰	60	33	20	66	81	30	0	10	55	46	45	40,5
	Bellarosa Minore	2,5 ‰	97	50	65	41	112	91	90	77	6		0	62,9
MESO..	S'Ena Arrubia	18 ‰	0	17	25	91	159	130	100	260	208	280	330	129,0
	Marceddì	18 ‰	0	0	10	63	113	149	206	10	16	118	10	62,4
POLI..	Is Benas	28 ‰	0	0	1	2	0	5	108	2	30	0	2	12,9
	Santa Giusta	32 ‰	0	659	190	581	632	611	560	840	485	350	86	453,4
	Corru S'Ittiri	35 ‰	0	135	149	139	140	71	0	30	357	25	47	98,9
	Santa Gilla	37 ‰	925	548	633	645	922	593	661	737			144	645,3
IPER..	Colòstrai	40 ‰									147	40	123	103,3
	Capoterra	41 ‰	240	150	210	208	191	270	121	181	142	42	45	172,7
	Mistras	43 ‰	79	236	189	256	305	170	152	180	923	1.185	2.693	579,4
	Sale 'e Porcus	50 ‰	0	0	0	0	0	0	0	0	0	0	0	0
	Bellarosa Maggiore	54 ‰									176	34	107	85,6
	Macchiareddu	79 ‰	58	40	61	49	101	65	55	40	182	99	172	83,6
	Salina Manna	86 ‰	0	0	0	0	0	0	0	0	0	0	0	0
	Quartu (salina de)	100 ‰	0	0	0	8	10	15	9	33	22	10	19	11,4

RÉFÉRENCES

BACCETTI, N., 1988. Lo svernamento del Cormorano in Italia. *Suppl. alle Ricerche di Biol. Selvagg.*, 15 : 1-170.

MOCCI DEMARTIS, A., 1992. Esperienze di monitoraggio operate sulla popolazione di *Phalacrocorax carbo sinensis* svernante negli stagni di Cagliari. *Riv. It. Orn.*, 62 : 153-163.

MOCCI DEMARTIS, A., in press. Incremento del cormorano svernante dal 1975 al 1991 negli stagni della Sardegna sud-occidentale (Cagliari, Oristano, S. Antioco). Atti 6e Convegno it. Ornit., Torino.

SACCHI, L., 1980. Ecologia animale, organismi ed ambiente. Bulzoli Editore, Roma.

E

GALLINULA CHLOROPUS (L.) EN TANT QU'INDICATEUR BIOLOGIQUE DANS UN ÉCOSYSTÈME D'ESTUAIRE

Attilio MOCCI DEMARTIS et Patrizia CANNATA

Département de biologie animale et d'écologie. Université de Cagliari. Italie

Etant donné le caractère méfiant de la Poule d'eau (*Gallinula chloropus*), on pourrait croire que les rives à végétation touffue fournissant une bonne protection sont les plus favorables à l'espèce tandis que la présence de l'homme lui est plus défavorable. Pourtant, la bibliographie nous rapporte que l'espèce foisonne près des égouts des villes. Pour vérifier ces assertions, nous avons étudié un canal d'estuaire pollué (Mammarranca) près de la ville de Cagliari (Sardaigne). Nous l'avons divisé en 10 stations, présentant différentes combinaisons des trois facteurs limitants (Fig. 1). Des données de ces combinaisons rapportées dans le tableau 1, on constate que lorsque la végétation est insuffisante et qu'il y a absence absolue d'hommes (station 7), l'espèce atteint un haut niveau de densité (9, 4 ind.), même en l'abence de sorties d'égout. Au contraire lorsque les avantages présentés par un plus grand taux de végétation sont contrebalancés par le maximum de présence humaine (stations 3 et 5) l'espèce n'atteint des valeurs élevés que lorsqu'il y beaucoup d'écoulements d'égout.

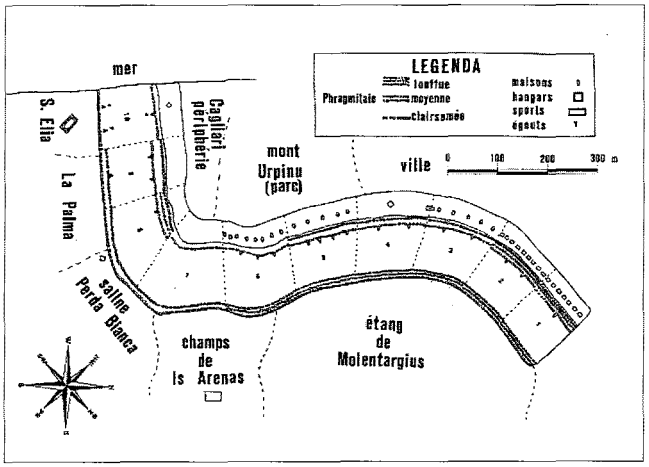


Fig. 1 - Schéma du canal de Mammarranca côtoyant l'étang de Molentargius aux environs de Cagliari. Les 10 stations d'observation présentent une différente densité de végétation sur les rives *(Phragmitaie)*, une présence humaine variable et des nombreuses sorties d'égouts.

En un mot, le facteur limitant le plus nuisible à l'espèce est sans doute la présence de l'homme partiellement contrebalancée par un nombre élevé de sorties d'égout qui signifient un plus grand apport alimentaire.

Par contre, la végétation ne paraît pas être déterminante et essentielle à la présence de l'espèce. En effet, la Poule d'eau ne semble pas être dérangée par la situation la plus apparemment défavorable (véget. clairsemée) à condition qu'elle s'accompagne d'une absence d'humains. De même, les cas de végétation touffue (stations 1 2 8) n'ont pas constitué un facteur d'attraction pour l'espèce qui n'a atteint que des index de densité très faibles (3,1 - 4,6 ind.) même en présence d'un petit nombre d'hommes et de sorties d'égout.

Enfin, les égouts assument un rôle alternatif en annulant en partie l'action de dérangement de l'homme sur l'espèce et assurant une source alimentaire importante.

Stations	N. moy. ind.	Végétation			Présence humaine				N. débouquements d'égouts				
		rare	moyenne	touffue	absente	hangars	sport	maisons	0	1	2	3	4
1	4,6			X		X				X			
2	3,1			X		X					X		
3	5,8		X					X			X		
4	4,9		X				X				X		
5	7,1		X					X					X
6	7,7	X						X				X	
7	9,4	X			X				X				
8	4,6			X			X			X			
9	4,3		X		X							X	
10	4,2	X					X				X		

Tableau 1. Combinaison des facteurs présents dans les 10 stations du canal, chacune étant longue de 100 m.

ÉVOLUTION MENSUELLE DES CONDITIONS HYDROLOGIQUES AU COURS D'UN CYCLE ANNUEL DANS UNE LAGUNE MÉDITERRANÉENNE : LE LAC MELLAH (EL KALA - ALGÉRIE)

W. REFES et S. GRIMES

Inst. des Sciences de la Mer et de l'Aménagement du Littoral. B.P.90. Alger 1er Nov., Algérie

Le lac Mellah, situé à l'est de la côte algérienne près de la ville d'El Kala, est une lagune saumâtre d'environ 865ha. L'intérêt de ce travail réside dans le fait de mettre en évidence les changements hydrologiques subis par la lagune après les aménagements effectués en 1988 sur le chenal reliant le lac à la mer, qui ont permis une amélioration des échanges.

Un suivi mensuel pendant treize mois (mai 1991 à mai 1992) au niveau des eaux superficielles de deux stations a permis de mesurer la température, la salinité et les teneurs des eaux en oxygène dissous à partir de sondes spécifiques. Les fractions inorganiques et organiques de la matière en suspension sont déterminées selon la technique préconisée par ARZUL *et al.* (1990).

Le cycle des températures fait ressortir deux grandes périodes thermiques : une période chaude de mai à août avec un maximum en juillet (29°C) et une période froide de septembre à avril avec un minimum en janvier (4.5°C). Ces fluctuations thermiques de l'eau sont en relation avec les conditions climatiques locales. Les salinités relevées présentent des fluctuations irrégulières mettant en évidence deux périodes halines : une période de salinité importante de mai à novembre avec un maximum en novembre (33.25‰), qui coïncide avec la saison sèche et une période de faible salinité entre décembre et avril avec un minimum en janvier (18.73‰). Ces variations de la salinité des eaux sont dues à l'influence des eaux marines pénétrant par le chenal, aux apports des oueds et aux conditions météorologiques particulières, notamment les précipitations et l'évaporation. Les teneurs en oxygène dissous des eaux présentent en période hivernale des concentrations élevées : 14.6 mg/l en janvier, soit un taux de saturation de 179%, et en période estivale des concentrations faibles : 4.38 mg/l en août (taux de saturation de 97%). Ainsi les teneurs notées révèlent une bonne oxygénation des eaux au cours de l'année, en relation étroite avec les variations de la température. Les variations mensuelles de la matière en suspension indiquent une charge particulaire importante avec un maximum en décembre (67.75 mg/l) et un minimum en mai (31.76 mg/l). La matière organique particulaire présente une forte concentration en août (45.02 mg/l) et une faible concentration en mai (9.69 mg/l); tandis que pour la matière inorganique particulaire le maximum est en décembre (37.91 mg/l) et le minimum en août (7.88 mg/l). Ces fluctuations de la matière particulaire, sont en relation étroite avec la production biologique de la colonne d'eau, les apports terrigènes des oueds et la remise en suspension des sédiments du fond.

Les conditions hydrologiques observées pendant la période d'étude sont caractérisées par des fluctuations importantes de la salinité (18-33%) et de la température (4.5-29°C), avec un taux de saturation en oxygène dissous supérieur à 60% et une charge sestonique importante.

La comparaison de nos résultats avec les données obtenues de décembre 1979 à novembre 1980 par SEMROUD (1983) montre que les périodes de fluctuation des paramètres hydrologiques sont similaires dans l'ensemble : une période hivernale (température et salinité faibles) et une période estivale (température et salinité élevées) avec une différence importante dans les écarts thermiques due à des températures atmosphériques hivernales basses en 1991/92 par rapport à la période d'étude 1979/80; l'augmentation des salinités découle des aménagements du chenal effectués en 1988, qui se sont traduits par une augmentation des échanges lac-mer, provoquant une "marinisation" lente et progressive des eaux du lac.

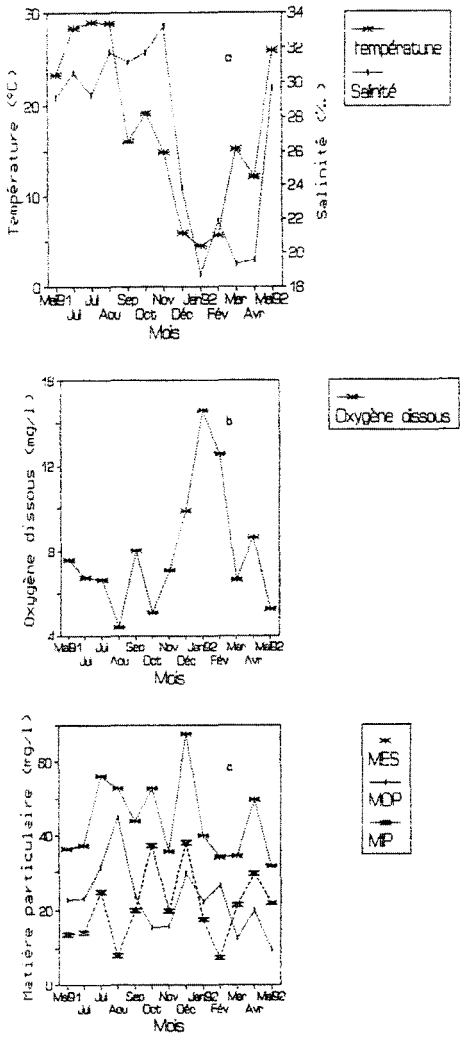


Fig.1 : évolution des moyennes mensuelles des paramètres hydrologiques

RÉFÉRENCES:

ARZUL G., CHARDY P., GROS P. & MONBET Y.,1990. Apports nutritifs par la matière organique en suspension en baie de Saint Brieuc. J.R.O., 15(3/4) : 110-115.

SEMROUD R.,1983. Contribution à l'étude écologique des milieux saumâtres méditerranéens: le lac Mellah (El Kala, Algérie).Thèse Doctorat 3ème cycle U.S.T.H.B. (Alger), 120 p.

ACTIVITÉS DE RECHERCHE SUR LES DIATOMÉES BENTHIQUES DANS LA LAGUNE DE VENISE : APPROCHE MÉTHODOLOGIQUE

Claudio TOLOMIO et Emanuela MOSCHIN

Dipartimento di Biologia, Università di Padova, Italia

Dans le cadre des recherches biologiques effectuées dans la lagune de Venise, nous étudions depuis plusieurs années la composante benthique des microalgues, vu le rôle très important qu'elles revêtent dans la production primaire des écosystèmes côtiers. Les diatomées, en particulier, répresentent la fraction la plus significative parmi les organismes qui colonisent le substrat. En effet, ces micro-organismes pionniers, de même que les bactéries, préparent le substrat à la colonisation des organismes plus grands comme les algues benthiques et les invertébrés. Après des études préliminaires dans les eaux des viviers avec des techniques très simples (Fig. 1a: TOLOMIO & ANDREOLI, 1989; TOLOMIO *et al.*, 1991) à partir d'octobre 1987, le microphytobenthos de la lagune vénitienne a été analysé aussi bien au microscope photonique qu'au microscope électronique à balayage. On a effectué un premier cycle d'observations (oct. 1987-oct. 1988) près de la Stazione Idrobiologica di Chioggia (bassin méridional), en utilisant des cuves de stabulation alimentées par les eaux de marée montante; on a employé des substrats artificiels (lames de verre microscopiques ou tablettes de plexiglas, de fibre résine, d'aluminium et de cuivre, collés sur des lames de verre) et des substrats naturels (tablettes de granit, de basalte, de calcaire et de bois). Les lames de verre ont été insérées en position verticale dans des supports en plexiglas faits exprès (Fig. 1b) et immergés pendant une période de trente jours. Quelques lames de verre ont été insérées horizontalement, en considérant soit la face supérieure, soit la face inférieure. Pour étudier l'influence de la durée d'immersion, une série de lames de verre a été laissée *in situ* pendant deux semaines seulement. Un deuxième cycle d'observations s'est déroulé de janvier à décembre 1991 dans une station localisée au nord de l'île de S. Domenico (Chioggia), suivant la méthode précédemment adoptée, mais modifiant l'inclination des lames de verre (45°) au moyen de nouveaux supports (Fig. 1c). Dans cette station, nous avons aussi récolté des échantillons de phytoplancton, vu l'étroite relation entre les diatomées benthiques et pélagiques.

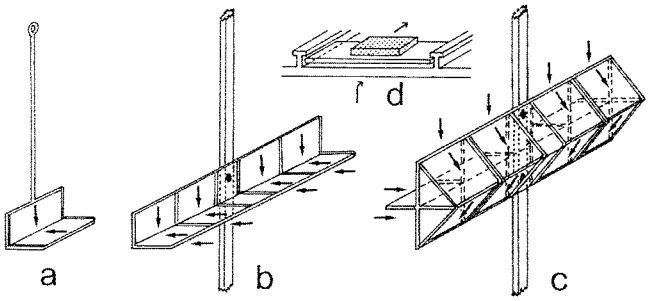


Fig. 1: Supports divers utilisés pour la pose *in situ* des lames de verre ou des substrats collés sur les lames. Les flèches indiquent la position des lames. En haut (d) détail du système d'insertion des lames.

Une expérimentation similaire a été effectuée à partir de novembre 1991 jusqu'à octobre 1992 le long du Canale S. Nicolò (bassin septentrional) avec quelques modifications : durée d'immersion (quinze jours) et position du substrat (verticale). Pendant cette période, en considérant les effets du microfouling sur les surfaces lithiques, on a étudié aussi les communautés diatomiques qui colonisaient des matériaux habituellement utilisés pour la construction d'oeuvres (pierre d'Istrie, calcaire rouge, porphyre, trachite, brique cuite). On a encore employé des tablettes collées avec de la silicone sur les lames microscopiques; pour détacher les organismes on a d'abord gratté avec un bistouri, puis utilisé des ultra-sons. Les échantillons ainsi traités ont été observés par un microscope inversé.

Les résultats obtenus jusqu'à présent ont mis en évidence qu'il faut arriver à un compromis dans le choix aussi bien de la durée d'immersion que de la position du substrat. En conclusion:

a) Pour étudier l'évolution temporelle de la colonisation, il serait souhaitable d'analyser des échantillons qui ont été immergés pendant des périodes différentes (sept, quinze et trente jours), comme déjà expérimenté (SOLAZZI *et al.*, 1983).

b) La position verticale est à conseiller: les autres (horizontale, face supérieure et face inférieure, et inclinée de 45°) présentent plusieurs désavantages.

c) L'utilisation du verre seul en qualité de substrat peut être peu significative: la micromorphologie du substrat influence d'une façon considérable l'enracinement des organismes benthiques et la distribution des cellules.

d) Les observations au M.O.(évaluation quantitative) doivent être complétées par des observations au M.E.B. (analyse taxinomique détaillée, étude des rapports parmi les espèces - Fig. 2a - et avec le substrat - Fig. 2b -).

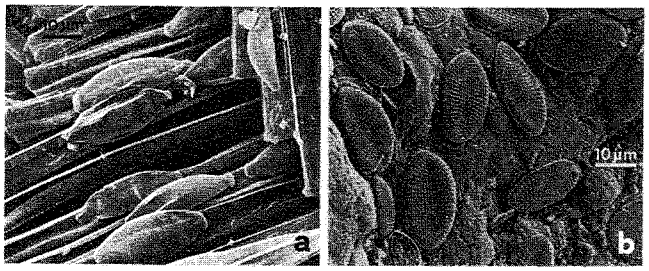


Fig. 2: a) *Amphora veneta* épiphyte sur *Bacillaria paradoxa*; b) *Cocconeis scutellum* qui s'adapte au substrat.

REFERENCES

SOLAZZI A., MARZOCCHI M., TOLOMIO C., MONTRESOR M. & SALAFIA C. 1983. Studio sul microfouling a Diatomee in Valle Ca' Pisani (Delta del Po). Ott. 1977-Sett. 1978. *Riv. di Idrobiologia*, 22: 286-350.

TOLOMIO C. & ANDREOLI C. (1989) - Recherches sur le périphyton à Diatomées dans un vivier de la Lagune de Venise (Mai 1984-Mai 1985). *Diatom Research*, 4: 151-162.

TOLOMIO C., ANDREOLI C. & AVIGNONE M.T. (1991) - Contribution à la connaissance du périphyton diatomique des eaux saumâtres de la Valle Sparesera (Suite). *Diatom Research*, 6: 391-399.

* Travail effectué avec la contribution du MURST (60% et Projet Sistema Lagunare Veneziano).

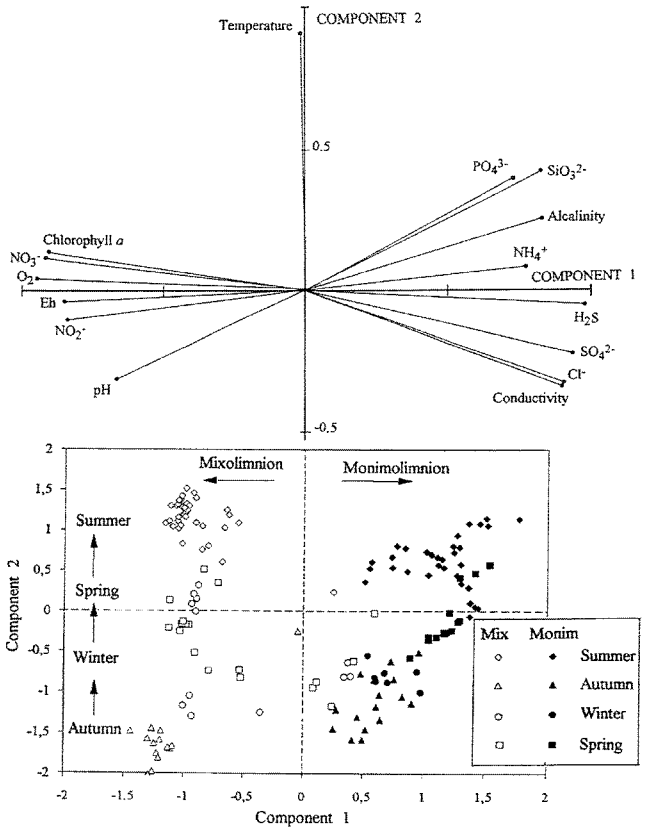
STATISTICAL INTERELATIONSHIPS AMONG PHYSICAL AND CHEMICAL PARAMETERS IN THE COASTAL LAGOON OF CULLERA (SPAIN)

Eduardo VICENTE, Rafael OLTRA and Maria Rosa MIRACLE

Departament d'Ecologia i Microbiologia. Facultat de Ciències Biològiques. Universitat de València. 46100 Burjassot (València). Spain

The lagoon of Cullera, 37 Km south of València, is an elongated lagoon (2.3 Km long and 7.5 m of maximum depth) with estuarine water circulation, which has varied a lot depending on the changes in its communication with the sea (RODRIGO *et al.* 1992). During the years 1980-81, a sand bar was well establi-shed at its mouth. Then, a permanent sea water wedge was found at the bottom of the basin and an oxicline was implan-ted between 3 and 5 m of depth. Several prin-cipal components analyses (PCA) have been done, using physico-chemical data from samples taken bimonthly during these years in the vertical profile of three locations (mouth, centre and source) and at different times of the day (usually early morning, midday and midnight) in the central point. The analysis with all the samples shows that, in the factorial plane of Components 1 and 2 (Fig. 1), the axis Component 1 (69% variance explained) clearly separates two groups of parameters and samples, which correspond to the sharp stratification of the water layers due to the marine water intrusion, that constituted an anoxic monimolimnion in those years. Thus, the parameters associated with the salinity of the waters, as well as phosphate, ammonia and sulphide, with high values in the bottom waters of the monimolimnion, are opposed to those associated with the aerobic conditions and the development of algal populations in the mixolimnion. Component 2 (11% variance explained) is a function of the seasonal variation; it is correlated positively with temperature and negatively with the parameters associated with salinity. The seasonal cycle of the lagoon is influenced by the fluctuation of the fresh-water inflow, due to irrigation of surrounding lands or rain periods. Thus, from spring to autumn a freshwater flow prevails, while during winter sea influence is more important. In winter, the marine water wedge arrived at the sampling station located near the source and an halocline was formed close to the surface, several meters above the oxic-anoxic interface. In spring, the wedge begins to retreat, but remains in the other sampling points located at the centre and mouth. During summer a sharp halocline coincident with the oxicline determines a strong stratification of the waters in the last mentioned sampling stations. All parameters showed strong gradients in the vertical profile. The results of the PCA analyses with all and part of the samples, confirmed that the depth variation of the physico-chemical parameters was much more important than their seasonal variation and that the three localities were much alike. The distribution of the planktonic communities (MIRACLE and VICENTE, 1983; ROJO and MIRACLE, 1989; OLTRA and MIRACLE, 1992) in this lagoon was concordant with the variation of these environmental parameters.

Fig.1. Results from a PCA analysis. Top: Correlation coeficients of the physico-chemical variates with the first two principal components. Bottom: Ordination of the samples in the plane defined by these components.



REFERENCES

MIRACLE, M.R.and VICENTE, E. 1983. Vertical distribution and rotifer concentration in the chemocline of meromictic lakes. *Hydrobiologia* ,104: 259-267.

OLTRA, R. and MIRACLE, M.R. 1992. Zooplankton of the meromictic coastal lagoon of Cullera (Spain). Rapp.Comm.int.Mer Médit.33: 99.

RODRIGO, M.A., CAMACHO, A., VICENTE, E. and MIRACLE, M.R. 1992. Inestability of the meromixis in the Coastal Lagoon of Cullera. *Rapp.Comm.int.Mer Médit.* 33 : 101.

ROJO, C. and MIRACLE, M.R. 1989. Phytoplankton Fluctuations during an Annual Cycle in the Coastal Lagoon of Cullera (Spain). *Int. Revue ges. Hydrobiol.* 74 : 179-194.

E

EFFECT OF SOME ENVIRONNEMENTAL AND PHYSIOLOGICAL FACTORS ON REPRODUCTIVE PARAMETERS OF *MUGIL CAPITO* DURING THE BREEDING SEASON

ZAKI M.I., EL-GREISY A.A., EL-GHARABAWY M.M. and BAGHDADI H.H.
National Institute of Oceanography and Fisheries, Alexandria, Egypt

The effect of some environnemental and physiological factors on reproductive parameters of *Mugil capito* in Egyptian fresh water fish farm has been studied. The present investigation revealed that the increase in photoperiod (18L+6D) as well as continuous illumination (24L) and continuous darkness (24D), showed an obvious decrease in the gonadasomatic index (GSI) compared to that of the control (6,5L+17,5D). This result is in affirmative agreement with that observed by LAM and SOH (1978) on *Siganus canaliculatus*.

The present study also revealed that the increase in temperature showed an obvious decrease in the GSI of both sexes of *Mugil capito* while the decrease in the temperature showed a decrease in the GSI of the female and a slight increase in the GSI of the male.

The GSI of the females increased within 1 week of 1500 IU injection. After 10 weeks, the gonads were resorbed and the GSI greatly decreased. There is no sharp difference in the GSI of the males after the injection.

The egg diameter of *Mugil capito* is affected greatly by the change in the environmental factors. The present study showed that the egg diameter is inversely proportional to the photoperiod.

From the relation between diameter and temperature it is observed that the increase or decrease in temperature is accompanied by a decrease in the values of egg diameter. In both cases, the frequency distribution was shifted to the lower values compared to that of the control. This result with that observed by TAMARU *et al.*, (1991) who studied the egg diameter of *Mugil capito*.

Concerning the effect of HCG injection on the egg diameter, it was observed that the frequency distribution of egg diameter was shifted to the longer diameter after 1 week of the injection. At the end of the experiment (10 weeks) it was shifted to the shorter one. The same increase in oocyte diameter was observed in the stimulated females of black porgy, *Acanthopragus schlegeli* due to the injection of HCG (CHANG *et al.*, 1991).

Milt volume in the group that received the highest dose (2 000 IU HCG) was greater than in the other group that received the lower dose (1 500 IU HCG). The present study also revealed that the sperm concentration in the seminal fluid decreased with time and with the number of times for the fish to give milt.

REFERENCES

CHANG C.F., YUEH W.S. and LEE M.F. 1991. Effects of LHRH-A and HCG on the steroid profiles of bisexual and mature male and female protandrous black porgy, *Acanthopagrus schlegeli*. *Aquaculture*, 92 : 83-92.

LAM Y.H. and SOH C.L. 1975. Effect of photoperiod on gonadalmaturation in the rabbit fish *Siagnus canaliculatus*, park 1797. *Aquaculture*, 5 : 407-410.

TAMARU C.S., KELLY C.D., LEE C.S., AIDA H. HANYU I. and GOETZ F. 1991. Steroid profiles during maturation and induced spawning of the striped mullet, *Mugil cephalus* L.. *Aquaculture*, 95 : 149-168.

EFFECT OF SOME ENVIRONNEMENTAL AND PHYSIOLOGICAL FACTORS ON SOME SEXUAL HORMONES OF *MUGIL CAPITO* DURING THE BREEDING SEASON

ZAKI M.I., EL-GREISY Z.A, BAGHDADI H.H. and EL-GHARABAWY M.M.
National Institute of Oceanography and Fisheries, Alexandria, Egypt

During the breeding season, experimental changes in some environmental factors were accompanied by hormonal changes in the plasma of *Mugil capito*. The present study includes testosterone as a main androgen and estradiol as a main estrogen. The present study revealed the the increase in photoperiod was accompanied by a decrease in plasma testosterone and estradiol levels in *Mugil capito* (table 1). The present work also revealed that the plasma levels of testosterone and estradiol are inversely proportional to the temperature (table 2). KADMON *et al.* (1985) reported that under a constant long photoperiod (16L+8D), estradiol levels were generally low in *Sparus auratus*. The salinity is an important factor for *Mugil capito*, since the fish does not spawn before entering the sea.

From table 3, it is obvious that the increase in the salinity is accompanied by an increase in the plasma testosterone and estradiol levels of *Mugil capito*. The increase in estradiol levels due to the increase in salinity was also observed by QUERAT *et al.*, (1985b). When they place silver eels in a closed system containing artificial sea water, plasma concentrationq of estradiol were increased greatly in comparison with those of eels kept in fresh water. The plasma levels of the steroid hormones increased greatly after injection with 1 500 IU HCG (table 4).

Table 1. Effect of photoperiod on testosterone (ng/ml) and estradiol (pg/ml) levels of plasma of *Mugil capito* during the breeding season.

Condition	Testosterone ng/ml ± SD	Estradiol Pg/ml ± SD
control (6.5L + 17.5D)	0.270 ± 0.04	59 ± 20
18L + 6D	0.217 ± 0.11	29 ± 13
24L	0.182 ± 0.03	25 ± 4
24D	0.183 ± 0.04	18 ± 6
L.S.D. at 0.05	0.0123	7.3591

Table 2. Effect of temperature on testosterone (ng/ml) and estradiol (pg/ml) levels of plasma of *Mugil capito* during the breeding season.

Condition	Testosterone ng/ml ± sD	Estradiol Pg/ml ± sD
control (17.5°C)	0.270 ± 0.04	59 ± 20
15 °C	0.393 ± 0.28	59.5 ± 16
20 °C	0.190 ± 0.13	41.0 ± 15
L.S.D. at 0.05	0.0180	2.7352

Table 3. Effect of salinity on testosterone (ng/ml) and estradiol (pg/ml) levels of plasma of *Mugil capito* during the breeding season.

Condition	Testosterone ng/ml ± SD	Estradiol Pg/ml ± SD
control 3.4 ‰.	0.270 ± 0.04	59 ± 20
15 ‰.	0.298 ± 0.09	58 ± 32
25 ‰.	0.311 ± 0.14	62 ± 30
35 ‰.	0.335 ± 0.06	70 ± 20
38 ‰.	0.650 ± 0.45	71 ± 47
L.S.D. at 0.05	0.2757	7.9268

Table 4. Effect of HCG injection on the steroid hormones levels. (N.D = not detected)

Condition	Testosterone ng/ml		Progesterone ng/ml		Estradiol Pg/ml	
	F	M	F	M	F	M
	avg. ± SD	avg. ± SD	avg. ± SD	avg.± SD	avg.± SD	avg.± SD
Control	0.24±0.09	0.30±0.15	2.40±0.80	0.90±0.6	71.5±14.	54±11.0
Injected	0.48±0.29	0.67±0.28	4.60±2.47	1.60±0.5	157.5±23	N.D.

REFERENCES

KADMON G., YARON A. and GORDIN H. 1985. Sequence of gonadal events and estradiol levels in *Sparus auratus* (L.) under two photoperiod regimes. *J. Fish Biol.*, 26 : 609-620.

QUERAT B., HARDY A. AND LELOUP-HATEY J. 1985B. Augmentation de la production d'oestradiol -17 β chez l'anguille (*Anguilla anguilla* L.) argentée placée en circuit fermé d'eau de mer. Compte-rendus hebdomadaires des séances de l'Académie des sciences, série III, 301 : 869-872.

ÉVOLUTION DES PARAMÈTRES ENVIRONNEMENTAUX ET REPRODUCTION DE LA PALOURDE (*VENERUPIS DECUSSATA*) DANS LA LAGUNE MÉDITERRANÉENNE DE NADOR (MAROC)

Nasser Eddine ZINE[1] et Mohamed MENIOUI[2]

[1] Faculté des Sciences, B.P. 4010, Beni M'Hammed, Meknès, Maroc
[2] I S, BP. 703, Rabat-Agdal et CNR B.P.8027 Rabat, Maroc

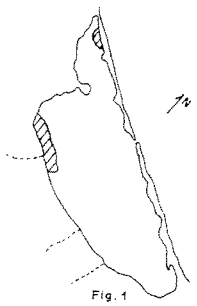


Fig. 1. Localisation des gisements naturels de *V. decussata*

L'espèce *Venerupis decussata* est exploitée dans la lagune de Nador (Fig. 1) depuis fort longtemps. Cependant, ce n'est qu'en 1985 qu'on a commencé à s'intéresser à sa reproduction à des fins aquacoles. BREBER (1986) a proposé l'étude des corrélations entre certains facteurs abiotiques, supposés agir sur le cycle gamétogénétique de cette espèce. Le but de cette étude est de mettre en évidence une éventuelle corrélation entre les facteurs du milieu et le cycle de reproduction de cette espèce. Pour cela, nous nous sommes basés sur des observations macroscopiques et des coupes histologiques aux niveaux des gonades. Les données ont été traitées par l'Analyse en Composantes Principales (ACP) et nous nous sommes contentés pour l'interprétation des résultats des deux premiers axes factoriels qui, à eux seuls, expriment près de 75% de l'inertie totale. L'analyse des données physico-chimiques permet de distinguer selon le plan factoriel F1*F2 deux principaux groupements. L'axe factoriel F1 (47,1% de l'inertie totale) permet d'isoler la période estivale (juin, juillet, août et septembre) où les conditions du milieu, en particulier celles intervenant dans la reproduction, sont optimales. La température est d'environ 26° C, la chlorophylle *a* de 5µg/l, la photopériode de 14 h. et la matière organique particulaire de 7,75 mg./l. Ces valeurs estivales sont bien supérieures aux moyennes annuelles : respectivement 19°C, 2,4 µg/l, 12 h. et 5,1 mg./l. Les analyses histologiques montrent des gonades hypertrophiées et le poids sec de l'individu standard est maximal (0,37 g.). Souvent 100 % des gamètes sont au stade de maturation maximale Cb (GALLOIS, 1977). C'est une phase de maturation maximale, où nous avons pu observer des pontes accidentelles; mais la ponte la plus importante est probablement celle qui a lieu à la fin de l'été et au début de l'automne et qui est due à un choc thermique par diminution de la température de l'eau qui passe de 27,1°C (sept.) à 22°C (oct.) et 17°C (nov.). Vers le pôle négatif de l'axe F1 (exprimant la période automnale), les individus ont tendance à "se vider"; le poids sec passe de 0,38 g.en septembre à 0,36 g. en octobre, 0,34 g.en novembre et 0,32 g. en décembre. Le pourcentage des individus au stade A diminue également, passant de 100% en été à 20% en octobre, puis 0% jusqu'en décembre. Ceci suppose une ponte automnale se poursuivant jusqu'en novembre; décembre serait une phase de repos sexuel. En janvier et février, on assiste à une reprise de l'activité gamétogénétique et une augmentation du poids sec : 13% des individus sont déjà au stade Cb en janvier et 23% au mois de février. Du point de vue physico-chimique, le pôle négatif de l'axe F1 paraît essentiellement exprimer les facteurs Pression atmosphérique et Précipitations. En effet, la pression atmosphérique est à son maximum en décembre (phase de repos sexuel). Aussi, nous pensons que l'augmentation la pression athmosphérique, agissant sur le niveau de la lagune, crée des conditions d'humectation défavorables, entravant la gamétogenèse. Les précipitations sont les plus importantes (21,3 mm. en moyenne contre 7,8 mm. annuelle) en octobre, novembre, janvier et février. L'Axe F2 (27,5% de l'inertie totale) s'explique surtout par la période printanière (mars, avril et mai) et, aussi, par le poids sec, relativement faible. Au début de cette phase, aucun stade C n'a été observé ce qui pourrait s'expliquer par une ponte au début du mois de mars. Cette ponte, certes moins importante que celle de l'automne, serait provoquée par un stimulus mécanique dû à une chute de la pression atmosphérique et donc à une augmentation du plan d'eau. A la fin du mois de mars, 100% des individus sont à nouveau au stade B; ils donnent 100% du stade Ca en d'avril et 100% de stade Cb en juin. Les conditions du milieu sont également favorables. En effet, l'axe F2 paraît exprimer le facteur oxygène qui atteint 104,5% (86% de moyenne), à cause de l'augmentation du niveau de la lagune, suite à une diminution de la pression atmosphérique et au brassage des eaux par les vents NE dominants. Mais, bien que les gamètes soient à des stades avancés de développement, le poids sec reste de faible valeur (0,25 g.). C'est probablement parce que, le milieu se montrant très pauvre en substances nutritives en hiver, l'animal puise sur ses propres réserves. Ce n'est que vers la fin de l'hiver que le poids sec commence à augmenter avec l'augmentation de la température, de la concentration de la chlorophylle *a* et de la matière organique. En conclusion, le cycle gamétogénétique de l'espèce *V. decussata* dans la lagune de Nador s'étendrait de mars à octobre. Il se caractérise par deux principales pontes, automnale et printanière, avec des pontes accidentelles durant la période du cycle. La reproduction dépendrait pour la maturation des gamètes de la température, la photopériode et la nutrition et, pour la ponte, de la température et la pression atmosphérique. La ponte parait induite par une brusque diminution de la température à la fin de la période estivale : de plus de 26°C en été à 22°C au mois d'octobre. Pour avoir une bonne maturité dans la lagune de Nador, la photopériode devrait être d'au moins 14 h., la température de 26°C, la teneur en chlorophylle *a* de 5 µg/l, et la concentration de matière organique particu-laire de près de 7,5 mg./l. Le repos sexuel dépend essentiellement de la pression atmosphérique qui entraîne une diminution du taux d'humectation près de la bordure continentale. La connaissance de ces données nous permettra d'obtenir dans des conditions expérimentales, une maturité hors-saison et d'assurer ainsi une production en naissains toute l'année.

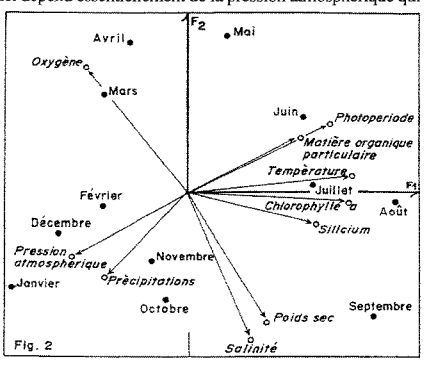


Fig. 2. Distribution des facteurs abiotiques et biotiques dans le plan factoriel F1*F2

REFERENCES

BREBER P. 1986 -La reproduction de *V. decussata* (L.) à Mar chica. Rap. mission à Nador de la FAO TR/86/06: 4p.

GALLOIS D. 1977 - Sur la reproduction des palourdes *Venerupis decussata* (L.) et des clovisses *V.aurea* (G.) de l'Etang de Thau (Herault). *Vie et Milieu* Vol.XXVII, Fas. 2, ser. A :235-254.

APERÇU SUR LA BIOLOGIE D'UNE POPULATION EXPLOITÉE DE PALOURDE (*VENERUPIS DECUSSATA*) DANS LA LAGUNE MÉDITERRANÉENNE DE NADOR (MAROC)

Nasser Eddine ZINE[1] et Mohamed MENIOUI[2]

[1] Faculté des Sciences, B.P. 4010, Beni M'Hammed, Meknès, Maroc
[2] I S, BP. 703, Rabat-Agdal et CNR B.P.8027 Rabat, Maroc

La "Mar Chica" de Nador (35°7'N à 35°16'N, 2°44' W à 2°60'W) abrite un gisement naturel de palourde concentré à Beni-Ensar et sur la bordure continentale alimentée par d'importants apports d'eaux douces. Cette étude a porté sur la deuxième population et son objectif est de dégager l'évolution de certains paramètres biologiques de cette espèce peu étudiée le long des côtes marocaines. Cette population présente deux principales phases gamétogénétiques (Fig.1). La première, estivale, avec un poids sec élevé (0,4 g.pour 0,33 g de moyenne) et où les conditions du milieu sont optimales (Zine, 1989). Cette phase est suivie d'une importante diminution du poids sec correspondant à la ponte automnale, qui pourrait s'expliquer par un stimulus mécanique dû aux variations du niveau de la lagune (TARDY, 1982) ou à un stimulus thermique dû à la chute de la température qui passe de 27°C (sept.) à 22°C (oct.) et 17°C (nov.). La deuxième période, fin hiver-début printemps, se caractérise également par un poids sec relativement élevé (0,38 g.).

La structure polymodale de l'histogramme de fréquence (fig. 2) suggère que le recrutement dans cette lagune s'effectue en plusieurs phases, en relation avec le cycle gamétogénétique. Le premier recrutement est automnal, avec une cohorte de 5 mm. et une amplitude d'environ 8% de la population totale. Le second recrutement, post-printanier, correspond à une cohorte recrutée avec une taille de 12 mm. et une amplitude, plus faible, d'environ 2%. La différence d'amplitudes entre les deux recrutements permet de mettre en évidence l'importance de la cohorte automnale jouissant de températures, de pluviométrie et, donc de salinité, favorables à la fixation des larves. Tandis que la cohorte née juste avant l'été est défavorisée par des températures, des salinités élevées, empêchant la fixation des larves ainsi que par de forts taux de pollution. Ce même phénomène a été observé par GUELORGET *et al.*, (1980) dans l'étang de Prévost.

La figure 3 montre que la densité moyenne atteint son maximum (61 ind./m^2) à la fin de la période printanière, suite au recrutement automnal (la durée de la vie larvaire est d'environ deux mois). Cet enrichissement quantitatif printano-estival est suivi d'une diminution, surtout à partir du mois d'août, de l'effectif de la population (11 ind./m^2 à la fin d'octobre) qui paraît liée à plusieurs facteurs dont un faible recrutement printanier, une forte mortalité due aux intempéries, au remaniement du substrat et aux fortes chaleurs estivales, à la migration des individus adultes vers les eaux plus fraîches et profondes et aussi une forte pression de la pêche, surtout pendant cette période estivale touristique. Le recrutement automnal contribue à la reconstitution progressive de la population; les températures, redevenant clémentes permettent aux individus adultes de remonter vers la surface. Cet enrichissement se poursuit pratiquement jusqu'en avril (45 ind./m^2), avec, cependant, une légère diminution des effectifs en février due à la migration verticale (dans le substrat) des adultes et aux mortalités hivernales des naissains. Au début du cycle, la biomasse (fig. 3) est à son plus faible niveau (0,025 g.) suite au recrutement automnal d'individus juvéniles. Ces nouveaux recrus, augmentant de taille, entraînent une augmentation de la biomasse moyenne, jusqu'en août où la chaleur estivale induit une diminution de la densité et, par conséquent, de la biomasse. Cette diminution à partir d'octobre s'explique, d'une part, par l'apport de naissains qui augmente la densité de la population en diminuant sa biomasse moyenne et, d'autre part, par la principale ponte automnale qui entraîne une diminution des poids des individus ayant effectué leurs pontes, mais aussi par la période hivernale contraignant les individus à puiser sur leurs réserves.

Au début du cycle, la population est dense, mais essentiellement juvénile (10 mm.). En augmentant de taille, elle entraîne une augmentation de la croissance moyenne (fig 4) jusqu'en juillet pour se stabiliser à 23 mm. L'enrichissement de la population par les juveniles du recrutement automnal entraîne une augmentation de la densité, une diminution de la biomasse moyenne, mais, surtout, une diminution d'abord modérée puis accentuée de la taille moyenne de la population. Les conditions physico-chimiques des eaux de la lagune de Nador et les données biologiques sur cette espèce montrent que la lagune est propice à la vénériculture. Elle y présente, en effet, un taux de croissance relativement rapide, une maturité sexuelle précoce, deux recrutements auxquels s'ajoutent des pontes accidentelles qui assurent la pérennité de l'espèce.

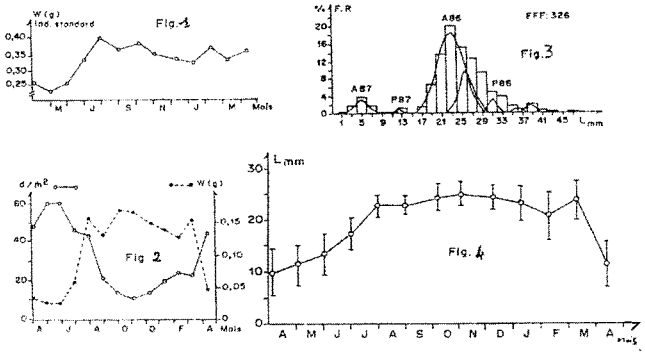


Fig.1. Evolution du poids sec d'un individu standard de 34 mm.
Fig.2. Structure polymodale de V.decussata. **Fig. 3.** Evolution de la densité et de la biomasse moyennes. **Fig.4.** Evolution de la croissance moyenne.

REFERENCES

GUELORGET O., MAYERE C. et AMANIEU M. 1980 - Croissance, biomasse et production de *Venerupis decussata* et *V. aurea* dans une lagune méditerranéenne. L'étang de Prévost à Palavas. *Vie marine*, Vol.2:25-48.

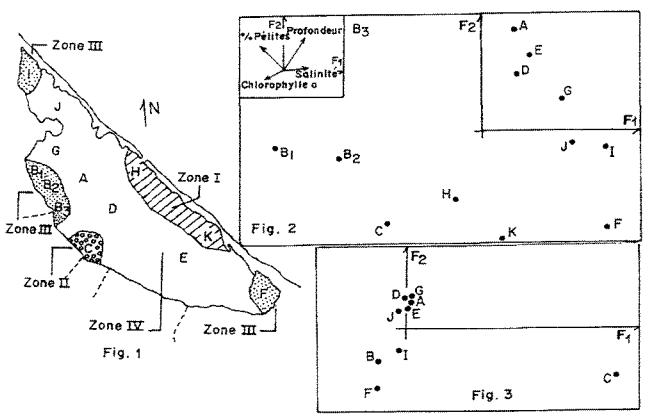
TARDY T. 1982 - Action des facteurs externes sur la sexualité des mollusques gastéropodes aquatiques. *Bull. Soc. Zool. France*. T.107, 1: 71-86.

ZINE N.E., 1989 - Etude de la malacofaune de la lagune de Nador et dynamique de population de *Venerupis decussata* (L.). Thèse 3ème cycle, Univ. Mohammed V, Rabat. 184 p

CONTRIBUTION A L'ÉTUDE TYPOLOGIQUE D'UN MILIEU LAGUNAIRE MÉDITERRANÉEN (LAGUNE DE NADOR-MAROC)

Nasser Eddine ZINE[1] et Mohamed MENIOUI[2]
[1] Faculté des Sciences, B.P. 4010, Beni M'Hammed, Meknès, Maroc
[2] I S, BP. 703, Rabat-Agdal et CNR B.P.8027 Rabat, Maroc

La "Mar chica" de Nador constitue l'unique enceinte lagunaire méditerranéenne du Maroc et la plus grande de toutes les lagunes marocaines. Les études concernant la zonation biologique sont rares si l'on excepte quelques contributions telles que celles de SAUBADE (1979) GUELORGET *et al.* (1984), CLANZIG (1989), MENIOUI ET ZINE (1992). Le but de ce travail est d'effectuer une zonation, en fonction des conditions du milieu, de la malacofaune dans cette enceinte (fig. 1). Ces données hétérogènes sont traitées par l'Analyse en Composantes Principales (ACP) sous forme de valeurs moyennes annuelles; il s'agit de la température, la profondeur, le taux de pelites, l'oxygène dissous, la salinité, le pH, la chlorophylle *a*, alors que pour les données faunistiques, elles sont traitées sous forme d'abondances annuelles par Analyse Factorielle des Correspondances (AFC). L'analyse par l'ACP des données (fig. 2) montre que dans le plan factoriel F1*F2, l'axe F1 (41,9%) permet d'isoler les stations B1, B2, B3 et C, soumises à des apports continentaux et caractérisées par un taux moyen de chlorophylle *a* de 3,2 µg/l, une salinité moyenne de 26,4‰. Les autres stations ont un taux de chlorophylle *a* faible moyennant 0,97 µg/l. et une salinité moyenne relativement élevée de 37,1‰ . L'axe F2 (21,4%) exprime surtout les facteurs "profondeur" et "taux de pélites". Il permet de distinguer deux groupements de stations: celles du milieu de la lagune (A, E, D, G et J) avec une profondeur supérieure à 6 mètres (côté positif) et celles dont la profondeur est relativement faible, ne dépassant pas 1,5 mètre (côté négatif). L'isolement de la station B3 (profondeur = 1,5 m) du côté positif de l'axe F2 est essentiellement dû à l'important taux de pélites (19,93 %), par rapport à celui d'autres stations telles que K (0,01%) ou C (0,49%) par exemple. L'axe F3 (17,9%) exprime le facteur oxygène et répartit l'ensemble des stations en trois groupements : les stations B1, B2, B3 et C, les moins oxygénées (92% en moyenne), les stations I, F et J qui ont un taux intermédiaire (96,8% à 97,2%) alors que dans les autres stations la valeur de l'oxygène dépasse toujours 98%. En ce qui concerne la biotypologie de la malacofaune (Fig.3), la pauvreté des stations K et H nous a amenés à les traiter en éléments supplémentaires. Elles sont pratiquement azoïques, caractérisées par un substrat instable, un taux de pélites très faible et constituent, à notre sens, une première zone (Zone I) Le plan factoriel F1*F2 (60,9%) montre un isolement de la station C, qualitativement pauvre (8 espèces) et quantitativement dominée par *Corbula gibba* (91,1% du total des mollusques), espèce des milieux riches en matière organique (NODOT *et al.*, 1984). C'est une station qui reçoit des rejets surtout de type industriel drainés par l'Oued Selouane et correspond à une deuxième zone (Zone II). Le troisième groupement est constitué par les stations B1, B2, B3, F et I qualitativement riches (entre 16 et 21 espèces) mais quantitativement très pauvres. Elles sont caractérisées par des apports de matière organique en provenance de la ville de Nador (B1, B2 et B3) ou par le phénomène d'eutrophisation dû au confinement (I et F); ces dernières stations sont situées aux deux extrémités et sur de faibles profondeurs. Leur faune malacologique est essentiellement dominée par des espèces euryèces, parfois indicatrices d'instabilité du milieu et souvent caractéristiques de la biocénose des milieux lagunaires. Il s'agit, entre autres, de *Venerupis aurea, Tricolia speciosa, Abra alba, Jujubinus striatus, Modiolus phaseolinus* et *Gastrana fragilis*. Ces stations nous paraissent correspondre à une même zone (Zone III). Le quatrième groupement, correspondant à la Zone IV, englobe le reste des stations situées généralement au milieu de la lagune; la profondeur y est importante (> 6 m.), l'eau bien oxygénée (> 98%), le taux de pélites relativement élevé (9,56%). Les fonds y sont essentiellement tapissés par *Caulerpa prolifera*. Ces données paraissent exprimer les conditions typiques des milieux lagunaires, ce qui permet la mise en place et le développement d'une malacofaune benthique dominée par des espèces caractéristiques des milieux lagunaires euryèces et plus ou moins vasicoles telles que *Loripes lacteus, Corbula gibba, Lucina fragilis* et *Nucula sulcata*. Ces espèces représentent respectivement 36,4%, 26,8%, 14,5% et 5,5% du total de la malacofaune ce qui constitue un total de 83,2% de l'ensemble de ce groupe. L'étude de la structure de la malacofaune benthique et de sa typologie dans la lagune de Nador permettent de conclure que cette lagune subit une évolution régressive qui se manifeste par la prolifération de l'algue *Caulerpa prolifera* au détriment des herbiers, la prolifération d'espèces vasicoles telles que *Loripes lacteus, Corbula gibba, Lucina fragilis* ou *Nucula sulcata*, la grande abondance d'espèces trouvées uniquement à l'état de coquilles vides, ce qui est, entre autres, le cas de *Cerastoderma edule, Dentalium dentalis, Bittium reticulatum, etc.* Les conditions actuelles de cette lagune sont telles que très peu d'espèces en bénéficient, ce qui confère à ce milieu l'aspect structural d'un écotone plutôt que celui d'un écosystème.



Localisation des stations et des zones (Fig. 1). Distribution, selon le plan factoriel F1*F2, des stations en fonction des facteurs du milieu (Fig. 2). Distribution selon le plan factoriel F1*F2 des stations en fonction de la structure du peuplement malacologique (Fig.3)

REFERENCES

GLANZIC S. 1989 - Evolution des peuplements malacologiques de la lagune méditerranéenne de Nador. *Vie Milieu*. 39 (2): 71-76.

GUELORGET O. PERTHUISOT J.P., FRISONI G.F. et MONTI D. 1984 - Contribution à l'étude hydrochimique, sédimentologique et biologique de la lagune de Nador. Rapport mission FAO: 1-82.

SAUBADE A.M. 1979 - La malacofaune actuelle de la lagune de Nador. *Bull. Inst. géol. Bassin Aquitaine*, 26: 69-81.

ZINE N.E. et MENIOUI M. 1992 - Le peuplement malacologique de la lagune méditerranéenne de Nador (Maroc): Etat des connaissances. *Marine Life*. 2(1): 39-45.

SELECTIVE EXTRACTIONS OF HEAVY METAL IN THE SEDIMENT OF THE CONA MARSH

R. ZONTA[1], F. COLLAVINI[2], L. ZAGGIA[2], F. COSTA[1] and E. ARGESE[2]
[1] Istituto Studio Dinamica Grandi Masse, C.N.R., Venezia, Italy
[2] Facoltà Chimica Industriale, University of Venezia, Venezia, Italy

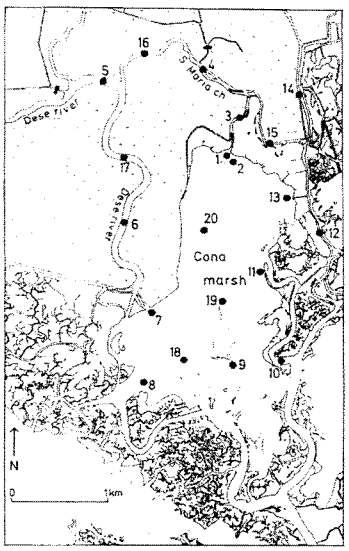


Fig.1. Map of Cona Marsh. Sampling sites are indicated.

Based on the results of a previous research on total anthropogenic heavy metal and grain-size distributions (ZONTA *et al.*, 1994), a sediment sampling was performed in the Cona Marsh (Venice Lagoon, Italy) to acquire a detailed description of metal accumulation and partitioning by a selective extraction sequence. The marsh (Fig. 1) is the shallow water estuarine system of the Dese River, one of the main tributaries of the lagoon basin. Morphology, tidal exchanges and the discharge of fresh water renders it a spatially diversified ecosystem with a complex hydrodynamical behaviour. Surface sediment samples (5 cm long) were collected by a syringe-type corer in the 20 sites indicated in Fig. 1, and immediately transferred in pyrex bottles containing the first extractive solution. In order to limit perturbation in the metal partitioning, the contact between the sample and atmospheric oxygen was avoided until the third extraction were performed. The adopted extraction sequence provided metal concentrations (GPHs) in four geochemical phases, as indicated in the following scheme :

1) Interstitial water and exchangeable metal (GPH1), by 1M deaerated ammonium acetate solution at pH=7 for 2 h.
2) Metal bound or specifically adsorbed to carbonates (GPH2), by 1M deaerated ammonium acetate solution adjusted to pH = 4.8 with acetic acid, for 6 hours.
3) Metal bound to Fe-Mn oxides (GPH3), by 0.04 M hydroxylamine hydrochloride in a 25% (v/v) acetic acid solution at 96°, for 6 hours.
4) Metal bound to organic matter and sulfides (GPH4), by 0.02 M nitric acid and 30% hydrogen peroxide at about pH=2 at 96° for 5 hours, and then at 25°C for 30 minutes after addition of 3.2 M ammonium acetate in 65% nitric acid diluted 1:4.

Concentration in leachates for eight metals were determined by atomic absorption spectrophotometry, and calculated on a dry weight basis. The grain-size distribution was also determined in the samples - after organic matter removal by oxidation with hydrogen peroxide - to permit a comparison with metal distribution for each GPHs. Volumetric percentages in 15 diameter classes, that correspond to one-half phi interval, in the 0.7<d<125 µm range were recorded by a Microtrac laser particle analyzer. The spatial distribution of the sum (Σ) of the four GPHs concentrations well reproduces the previously observed spatial distribution of total anthropogenic heavy metals in the marsh. Heavy metal partitioning generally differs from site to site. The coefficient of variation CV = (GPHs*%/σ) - where the numerator is the percentage concentration in the s-th phase referred to Σ- ranges in fact from 0.17 for Cu in GPH4 to 1.27 for Cd in GPH1. Nevertheless, the partitioning obtained with the average percentage in the 20 sites (Fig.2) may be considered sufficiently representative of the metal-sediment association in the whole marsh. Cd, Cr, Cu, Fe and Ni have a percentage lower than 1.0 in the interstitial water and exchangeable phase, while Pb (1.2%), Zn (2.0%) and Mn (5.6%) show significant values. These three metals also have a noticeable concentration associated to carbonates, particularly Mn and Pb which account for about 60% and 50% respectively; Cd is well represented (29%) while percentages of the other five metals are around 10. Fe-Mn oxides (GPH3) represent the principal association phase for Cd, Cr, Ni and Zn. About 78% of the Cu is in the GPH4, as it may be expected because of its strong affinity with organic matter. GPH4 also comprises about 40% of Fe, Ni and Cr, and from 10% to 20% of the remaining four metals; a significant part of these concentrations could be associated to sulfides (ZONTA *et al.*, 1993). The comparison between grain-size and metal spatial distributions emphasizes the role of finer particles for the accumulation of contaminant in the marsh sediment. Fig. 3 reports, as an example, the regression between Zn in GPH3 and particle content in the size interval 1.4<d<31µm. To a greater presence of finer particles in the sediment a higher metal concentration corresponds, evidencing the role of oxide coatings - that are generally present onto finer particles - as metal ligand. Fig. 3 also permits to show identify a zoning of the marsh with respect to either metal accumulation and finer particle content, with an increasing trend from the southern (S) to the central (C) and to the northern (N) zones and maxima in the correspondence of the zone dominated by the fresh water input (F).

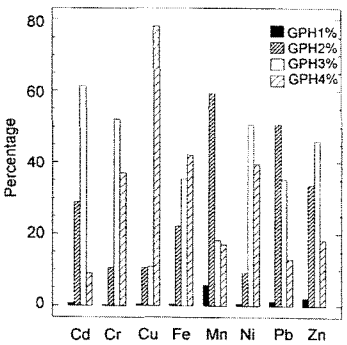


Fig. 2 Average partitioning of metals in the marsh.

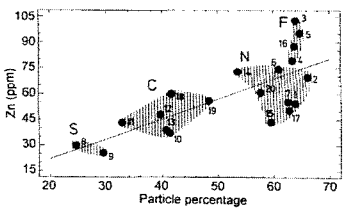


Fig. 3. Regression between Zn in GPH3 and particle content in the range 1.4<d<31 µm. The marsh zoning is indicated.

REFERENCES

ZONTA R.,ZAGGIA L. and ARGESE E., 1994. Heavy metal and grain-size distribution in estuarine shallow water sediments of the Cona Marsh (Venice Lagoon, Italy). *Sci. Tot. Environ.*, 151 : 19-28.

ZONTA R., ZAGGIA L., MISEROCCHI S. and ARGESE E., 1993. Effects of Acid Extractions on Iron Sulfides in the Sediment of the Venice Lagoon. Proc. 9th Int. Conf. "Heavy Metals in the Environment", Toronto - Canada (1993), 1 :181-184

SOME TYPICAL ASPECTS OF WATER CIRCULATION AND MIXING IN AN ESTUARY OF THE VENICE LAGOON

R. ZONTA[1], L. ZAGGIA[2], R. CECCHI[3],
S. RACCANELLI[4], S. VAZZOLER[1] and G. GHERMANDI[5]

[1] Istituto Studio Dinamica Grandi Masse, C.N.R., Venezia, Italy
[2] Dipartimento Scienze Ambientali, University of Venezia, Italy
[3] Istituto Geofisico e Geodetico, University of Messina, Italy
[4] EniChem SpA-SIA, Porto Marghera - Venezia, Italy
[5] Osservatorio Geofisico, University of Modena, Italy

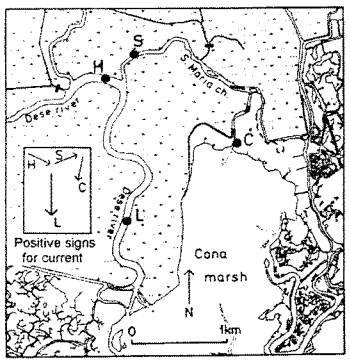


Fig. 1. Location of the four stations in the northern part of the Cona Marsh.

Once vehiculated in an estuary, heavy metals are subjected to a variety of interactions that are mainly governed by hydrodynamics and physico-chemistry at the fresh-salt water interface, and are capable to exert a marked influence on their partition. To study the behaviour of heavy metal discharged in the Venice Lagoon from the drainage basin, the Cona Marsh was chosen as a test area (BERNARDI *et al.*, 1988; GHERMANDI *et al.*, 1993). The marsh receives the fresh water input of the Dese river, an important tributary of the lagoon basin which collects contaminants from urban, industrial and agricultural sources. Some typical features of water circulation in this estaury, evidenced through field measurements made in different periods, are presented describing, as a typical case, the results obtained in June 1993. During a week-long field, continuous recordings of salinity, temperature and current were performed at four stations in the estuary (Fig.1), while other water physico-chemical parameters (dissolved oxygen, Eh, pH) were measured at the time of water sampling for chemical analysis. Suspended particle concentration, organic and inorganic carbon contents were determined after a two steps filtration through 8 and 0.4 µm pore-size polycarbonate membranes, using an expecially designed filtration apparatus (ZONTA et al., 1994).The original sample and the two filtrates were also analyzed for heavy metal concentration by P.I.X.E. and some filters were submitted to SEM/EDS analysis to investigate the particulate composition. The effect of the salt intrusion is depicted in the example of Figures 2. During the first part of the flood tide (α in Fig.2B), the greater part of the water column at station H is interested by fresh water, because of the river discharge occurred in the previous ebb phase (with a velocity of about 20 cm/s at 0.5 depth - Fig. 2A). The high salinity value observed in the bottom layer at the time of tide reversal is rather uncommon for this station and may be due more to seasonal than tidal conditions. This situation is successively altered by the arrival of fresher water previously discharged by the river, a part of which was "stored" in the S.Maria channel. This water is forced backward and then deviated upstream along the upper reach of Dese River by the action of the flood tide. The salt wedge espansion produces the resuspension of particles from the river bottom (Fig.2C, black dots), determining the observed turbidity increase in the bottom water layer, which starts at station L and interests afterwards the whole system. In the period of maximun upstream currents (β in Fig. 2B), no vertical salinity gradients are observable at station H, and resuspended particle concentration interests even the upper water layer at both stations L and H (Fig. 2C, white dots). Successively (γ in Fig.2B), prior to the flow reversal, the salt wedge at station H is restored, and salinity in the upper water layer decreases as a conse-quence of the reduction of tidal forcing. This is accompained by a decrease of turbidity in the whole water column at both stations H and L. The particle load travel-ling up and downstream between these stations, due to the friction on the river bed produced by the salt intrusion, the effect of the S. Maria channel on the circula-tion (GHERMANDI *et al.*, 1993), and salinity variations occurring in space and time along the estuary, strictly influence the behaviour of heavy metal and particularly the rate and intensity of adsorption/ desorption processes.

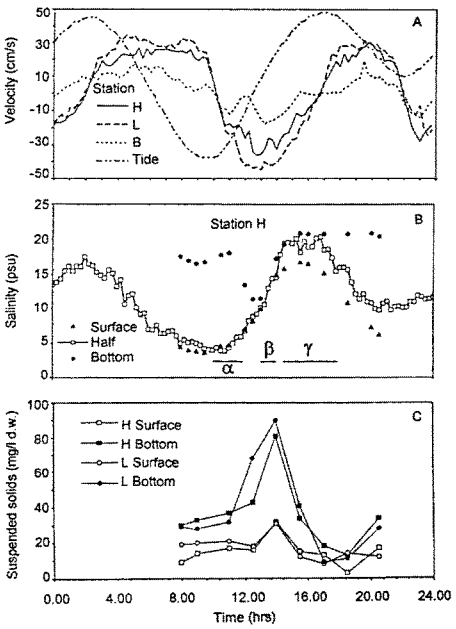


Fig. 2. Hydrodynamical and physico-chemical data measured on 23 June 1993 in Cona Marsh: current (A), salinity at station H (B), suspended particle concentration (d > 8 µm) at stations H and L.

REFERENCES

BERNARDI S., CECCHI R., COSTA F., GHERMANDI G., VAZZOLER S., ZONTA R., 1988. Preliminary Investigation on the Distribution of Heavy Metals in Surface Sediments of Cona Tidal Marsh (Venice Lagoon). *Il Nuovo Cimento*, 11C: 667-678.

GHERMANDI G., CAMPOLIETI D., CECCHI R., COSTA F., ZAGGIA L. and ZONTA R., 1993. Trace metal behaviour during salt and fresh water mixing in the Venice Lagoon. *Nucl. Instr. and Meth.*, B75: 330-333.

ZONTA R., CECCHI R., COSTA F., SIMIONATO F. and GHERMANDI G., 1994. A Filtration System for the Size Separation of Fresh Water Samples. *Sci. Tot. Environ.*, 143: 163-172.

G

COMITÉ GÉOLOGIE ET GÉOPHYSIQUE MARINES

Président : Andres MALDONADO
Vice-Présidents : Jannis MAKRIS et Yossi MART

STRUCTURE OF IZMIT BAY (THE EASTERN MARMARA SEA)

Mustafa AKGÜN and Mustafa ERGÜN

Dokuz Eylül Univ., Fac. of Engineering, Depart. of Geophysics, Bornova-Izmir, Turkey

As a result of the collision of the Arabian and Anatolian land masses during the middle Miocene, westerly escape of the Anatolian block introduced E-W compression in the western Turkey, which began to be relieved by N-S extension. The Izmit Bay lies along the line of North Anatolian Fault (NAF) which loses its dextral strike-slip displacement from East to West, and it splits into several fault strands definining a broad tectonic zone with associated high swarmlike seismic activity. As the Anatolian block moves west, its leading edge comes under the influence of the Aegean North-South extension and breaks up into discrete graben structures. The westward motion of the Anatolian block is not responsible for the extensional tectonic processes in the Aegean region which was existed before the iniation of NAF. There is major internal deformation within Anatolia, possibly involving counter clockwise rotational movements. Estimates of the average amount of North-South extension over the past 12-13 Ma are in between 30 to 50 percent in the region. The Marmara basin is the extension of the Thrace basin in the North and Northwest. During the middle Eocene, the subsidence of basement was occured creating the Thrace basin and the NAF uses the older tectonic structures in this region. According to the gravity interpretation there is a relative crustal thinning under the sea of Marmara. Zero contour of the Bouguer gravity anomaly follows the trend of the NAF zone but this trend bends to the NE-SW direction just before the Izmit Bay. The north of the NAF zone and its splay areas have positive Bouguer gravity values reaching up to 50-55 Mgals levels towards the Black sea coast. Moho gets shallower towards the Black sea from 25-30 km to 20 km. The Izmit Bay area has a localized gravity minimum due to sedimentary fill of about 3-4 km. The grabens around the sea of Marmara (Izmit, Iznik and Gemlik Bays, Yeniflehir-Bursa-Manyas) lie along the course of N and S strands of the NAF, have very strong strike-slip components. The Izmit Bay area is just located the at the eastern edge of the Marmara basin and it is stil under the strong influence of the dextral strike-slip fault with the tensional regime of the sea of Marmara and the western Turkey. In the Izmit Bay area the NAF has a pull-apart structure. From the geometry of the basin about 8 km right-lateral displacement can be deduced. The NAF must have used the weakness pooints in the sea of Marmara (i.e. the Thrace extensional Basin) which should have active before the Middle Eocene, with additional effects of counter clockwise rotations of blocks in the western Turkey and the Aegean sea. Active tectonics of both strike-slip and normal faults effect the recent sedimentary facies in the Izmit Bay. These will be documented from the high resolution seismic investigations in the region within the context of of the general tectonic regime of the region where the even the very recent sedimentary sequences are affected by the transform and growth faulss which are still active.

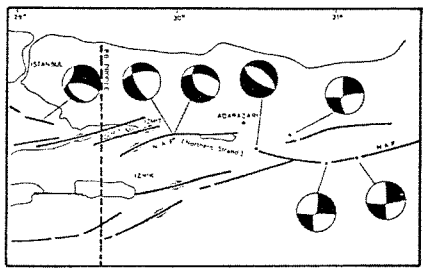


Fig. 1. Structural framework of the Izmit Bay area.

REFERENCES

AKGÜN M., 1987. Evaluation of the Izmit Bay and the surrounding area with the geophysical data. D.E.Univ., Inst. Mar. Sci. Tech. (Izmir-Turkey, M. Sc. Thesis, 84 p (in Turkish).

BARKA A. A., 1992, The North Anatolian Fault zone, *Annales Tectonicae*, Special Issue to Volume VI, p. 164-195.

CRAMPIN S. and EVANS R., 1986, Neotectonics of the Marmara Sea region of Turkey, *Journal of the Geological Society*, London, 143 : 343-348.

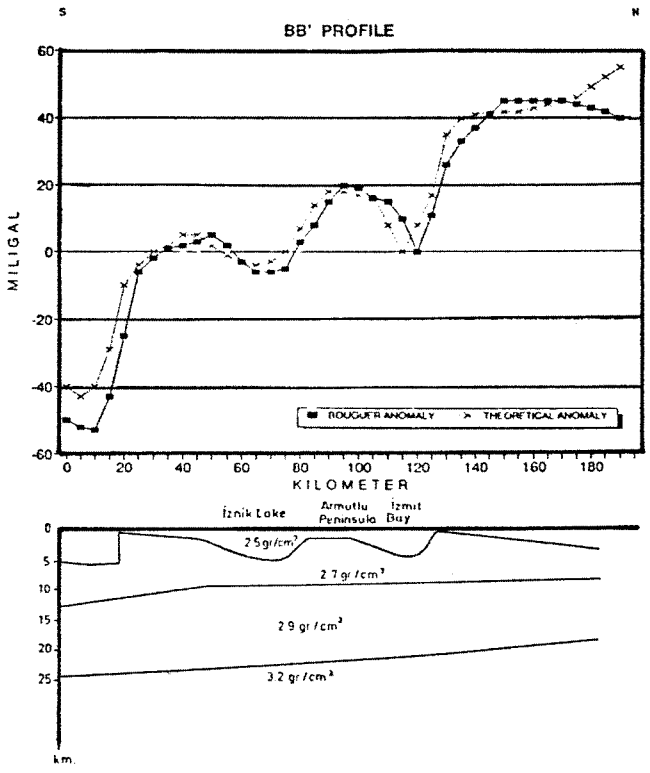


Fig. 2. Interpretation of the N-S Bouguergravity profile.

THE MUD BRECCIA CLASTS FROM THE MEDITERRANEAN RIDGE : THE RESULTS OF THE STUDY OF SUBSTANTIAL COMPOSITION

Grigorii G. AKHMANOV

Moscow State University, Geological Department, Vorobjevy Gory
Moscow, 119899, Russia

In 1993, during the TTR-3 Cruise of R/V Gelendzhik, some new mud volcanoes were discovered, located on the crest of the Mediterranean Ridge. The mud breccia from the newly discovered volcanoes is composed of subrounded clasts of different lithologies supported by a silty-mud matrix.

The breccia clasts are represented by a large variety of different rocks: limestones, sandstones, siltstones, and mudstones.

Precise description of the main types of the rocks obtained as clasts from the mud breccia was made. The types of rocks were determined on the basis of macrodescription, microdescription (more than three hundreds of thin sections), and the X-ray data. They provide an important information of the composition and genesis of the Lower-Middle Miocene deposits. The obtained lithologic data show that the Lower-Middle Miocene rocks of the Mediterranean Ridge were formed in deep-sea environments, far away from the continental slope. There show a prevalence of biogenic and hemipelagic sedimentations of marls and muds. A terrigenious matter was supplied periodically by gravity flows. Distant sources were the reason why coarse terrigenious material did not reach the depocentres, and only fine sediments were supplied in the study area thanks to deep-sea fans action. Coarser material was supplied rarely and formed accumulative bodies of suprafans consisted of silty and sandy sediments.

Thus, the genetic features of the defined rock types from the clasts from the mud volcanoes indicate deep-sea environments during their accumulation and the presence of distal turbidites in sedimentary sequence of the Mediterranean Ridge. This suggests that the turbidity currents from the African margin were capable to reach the Mediterranean Ridge crest in the Early-Middle Miocene time, and the Mediterranean Ridge was rather deeply submerged.

G

COASTAL DYNAMICS AND SEDIMENTARY CHARACTERISTICS OF THE AREA INFLUENCED BY THE RIVER SALSO'S HYDROGRAPHIC BASIN (SOUTH SICILY)

AMORE C., GEREMIA F., RANDAZZO G.

Istituto Policattedra di Oceanologia e Paleoecologia, Università degli Studi di Catania, Corso Italia, 55, 95129, Catania, Italia

Since the 1970's, within the framework of research on "Littoral Dynamics" financed by funds from the Ministry of Public Education and the Ministry for University Scientific and Technological Research, the Operative Unit of Catania University has carried out the study of Sicilian shorelines (AMORE *et al.*, 1988, 1993; BRAMBATI *et al.*, 1992; AMORE & RANDAZZO 1993a), focusing both on its submerged mouth apparatus and on the relation between riverborne material reaching the sea and its longshore distribution.

Within the philosophy of the River Unicum - one of a link between the apical part of the hydrographic basin, the coastal strip and the continental shelf in front of it - the Salso river was studied, which is the most important river in Sicily with a length of 132 km and a drainage basin of 2050 km^2, and which has its origins in the southern side of the Madonie Chain and flows close to Licata on the western limit of the Gulf of Gela.

The drainage basin of Salso River, with the carbonatic outcroppings of Complesso Panormide in the northern area, of the Numidic Flysch and of the Argille Scagliose in the central one and finally of the Chalky - Sulphurous Series in the southern one, is characterized by a solid load composed for 90% by pelitic material.

At present the mouth apparatus, which had been advancing until the 1960's, is strongly retreating because of the reduction of solid and liquid load and because of the enlargement of the port of Licata, which has deeply modified the littoral drift.

The morphology of the bottom in front of the mouth apparatus, which is slightly indented and not very homogeneous with those nearby, shows a wave - dominated "delta" (GALLOWAY, 1975), and was once definitely more pronounced. It has a gentle convexity on both sides which makes it comparable to the curved "deltas" of FISHER (1969).

The grain size spectra map (DOWLING, 1977) shows the maximum sedimentation in the eastern sector, due to the influence of the port of Licata; in fact the eastern quay protects the mouth apparatus from western storms. For eastern storms this quay determines a local circular current towards the East which erodes the shoreline and deposits in the shallower waters. In the deeper waters, instead, which are not directly influenced by the quay, the currents are always westward.

The textural characteristics of the sediments, shown on the basis of NOTA's classification (1958), have permitted the distinction of five facies: littoral, frontdelta, frontdelta - prodelta transition, prodelta and transition to the platform, characterized respectively by sands, pelitic sands, very sandy pelites, sandy pelites and pelites.

In the compositional characteristics of the sandy fraction, quartz prevails and its areal distribution seems due to the riverborne material instead of the longshore drift.

REFERENCES

AMORE C., BRAMBATI A., DI GERONIMO S., FINOCCHIARO F., GIUFFRIDA E., RANDAZZO G., 1988. Atlante delle spiagge italiane, Foglio 272 (Gela). C.N.R., P.F. Conservazione del suolo, Sott. Dinamica dei litorali, Roma.

AMORE C., GIUFFRIDA E., RANDAZZO G., 1993. Atlante delle spiagge italiane, Foglio 271 (Agrigento). C.N.R., P.F. Conservazione del suolo, Sott. Dinamica dei litorali, Roma. In stampa.

AMORE C., RANDAZZO G., 1993a. Textural features of sediments and temporal evolution of the littoral between Capo Passero and Capo Scalambri (South East Sicily). Coastal Zone 1993.

AMORE C., RANDAZZO G., 1993b. First data on the coastal dynamics and the sedimentary characteristics of the area influenced by the river Irminio's hidrographic basin (SE Sicily). International Symposium on Dynamics of Fluvial - Coastal System and Environmental Changes. San Benedetto del Tronto (Italia). 21 - 24/6/1993 .

BRAMBATI A., AMORE C., GIUFFRIDA E., RANDAZZO G., 1992. Relationship between the port structures and coastal dynamics in the Gulf of Gela (Sicily - Italy). Coastal Congress ICC - Kiel 1992.

DOWLING J., 1977. A grain size spectra map. *Jour. Sed. Petr.* 47, 1, 281-284.

FISHER W. L., BROWN L., SCOTT A., MC GOVERN J., 1969. Delta systems in the exploration for oil and gas : a research colloquium. Univ. Texas Bur. Econ. Geol. Austin.

GALLOWAY W. E., 1975. Process framework for describing the morphologic and stratigraphic evolution of deltaic depositional systems. In "Deltas: models for exploration". Broussard Ed., Houston Geol. Soc., 87-98.

NOTA D. J., 1958. Sediment of the Western Guiana Shelf. Thesis mededel. Landbouwhogeshool. Wegeningen. 98 pp.

THE BLACK SEA MUD VOLCANISM. ITS LITHOLOGY, GEOCHEMISTRY AND ORIGIN

Eugene I. BASOV

Moscow State University, Geological Department, Vorobjevy Gory, Moscow, 119899, Russia

In summer 1991 and 1993 aboard the R/V "Gelendzhik", the geological-geophysical investigations were carried out in the context of the UNESCO's Training and Education in Marine Science (TREDMAR) programme in the central part of the Black Sea.

Based on carrying out a number of analyses of sampled sediments and interpretation of geophysical data morphological features of the area, depositional environments, geochemistry, mineralogy and lithology of sediments and mud volcano breccia were studied.

The area of development of mud volcanism in the central part of the Black Sea is a very well displayed in relief through volcanic upbuildings of different shapes; the largest one are MSU and Yuzhmorgeologiya mud volcanoes (2.0 and 2.5 km in diameter, respectively).

The pelagic sediment shows the normal stratigraphic and lithological sequence of the deep-water Black Sea sediments, but at the same time displays a relationships with mud volcanism in this region, which is shown by the presence of slide and slump structures in sediments.

According to the morphological patterns of volcanoes, ages (by $\Delta^{14}C$ AMS) of halt of their activity and the lithological characteristics of breccia of mud volcanoes, at least two types of mud volcanoes in investigated area can be distinguished.

The first type is Tredmar type mud volcano which is active to-day and characterised by eruption of finer material (not coarser than sand fraction, less than 1mm) with dominance of minerals in breccia up to 90% of the sand fraction and high carbonate contents (10-12% $CaCO_3$) .

The second type is MSU and other studied volcanoes. They are characterised by mainly Upper Pleistocene and Holocene activity, the breccia mainly contains rock fragments which are represented by the coarse fraction (up to cobbles). In addition, the breccia contains a lowcarbonate content (usually less than 1% of $CaCO_3$).

The rock fragments from mud volcano breccia are represented by siltstones, sandstones and carbonate rocks. The dating by microfossil, pollen and spore and lithological analysis shows that siltstones were probably derived from the Maikopian formation (Oligocene-Lower Miocene) and sandstones may originate from Cretaceous (?) till Recent age.

The sediments from some cores were extremely gas-saturated and contained gas hydrates. The result of gas analysis demonstrate that methane makes up to 98% of the total gas composition. Supposedly, it is probably young biogenic gas that may be derived from Maikopian strata, which is extremely saturated by organic matter. The isotopic analyses of gas hydrates demonstrate stable volumes of $\Delta^{13}C$ from -63.3 to - 61.8‰, which also indicates the biogenic origin of gas hydrates.

All data show that this area of mud volcanism is active today and that the mud volcanoes located near to each other have different patterns of activity and sediment composition.

Finely, some idea of the mud volcanoes origin in the studied area is given.

LA SÉDIMENTATION GRAVITAIRE AU LARGE DE LA CORSE OCCIDENTALE

Gilbert BELLAICHE[1], Guy PAUTOT[2], Virginie GAULLIER[1] et Laurence DROZ[3]

[1] Laboratoire de Géodynamique sous-marine, URA CNRS 718. BP. 48. 06230 Villefranche-sur-mer, France

[2] IFREMER, Centre de Brest, BP. 70, 29280, Plouzané, France

[3] Laboratoire de Géodynamique sous-marine, URA CNRS 718. BP. 48. 06230 Villefranche-sur-mer. Actuellement à l'Université de Bretagne occidentale, France

Le sondeur multifaisceaux "Simrad EM12" de l'Atalante a permis une étude morphologique détaillée de l'ensemble de la marge corse menée de pair avec des relevés sismiques, 3,5 kHertz, gravimétriques et magnétométriques.

Cette étude a permis de montrer que le glacis de la marge occidentale de cette île est le siège de vastes épandages de matériel terrigène, mis en place par écoulements gravitaires et se présentant sous forme de corps sédimentaires de morphologie et de structure bien définies. Leur origine géographique a pu être retracée.

Le secteur Nord est soumis aux apports d'origine provençale acheminés par l'intermédiaire du canyon du Var et de son chenal profond.

Plus au Sud, les apports d'origine corse prédominent. Ils ont été acheminés par l'important réseau de canyons qui entaillent la pente de l'île et sont parfois reconnaissables jusqu'à plus de 100 km des côtes. Les appareils sédimentaires insulaires sont caractérisés d'une part, par une zone axiale plus ou moins déprimée à faciès acoustique fruste située dans le prolongement de la vallée sous-marine, et d'autre part par des levées latérales proéminentes à écho-faciès stratifiés.

Les analyses sismiques montrent que ces appareils corses semblent s'insérer sous les apports provençaux. Si l'on considère, à l'instar des appareils sédimentaires profonds de la marge rhodanienne, que la fin de la période de construction des appareils sédimentaires corses coïncide avec la fin de la dernière période glaciaire, il en résulte que le chenal profond du Var a continué dans ces régions à être actif pendant l'Holocène.

Enfin, dans le secteur tout à fait méridional, les apports d'origine sarde ont été acheminés par le canyon de Castelsardo et ont été vraisemblablement soumis à des contraintes tectoniques récentes.

Outre sa fonction bathymétrie, le sondeur multifaisceaux Simrad EM12D, grâce à la mise au point d'un logiciel par l'IFREMER, a permis d'acquérir l'image sonar des marges corses. Le produit imagerie est une représentation de l'amplitude du signal réverbéré sur le fond, corrigée de l'obliquité. Le signal est donc lui-même l'expression de la réflectivité du sol, paramètre qui traduit la morphologie et la nature du fond.

L'élargissement, au large de la Corse, du thalweg du chenal du Var est associé à des flèches de sédiments réfléchissants disposées en éventails et interprétées comme des zones de décharge sédimentaire. Plus au Sud, cet éventail recouvre les fonds très réfléchissants des remplissages de chenaux associés aux corps sédimentaires de provenance insulaire. Une telle disposition stratigraphique confirme les différences de fonctionnement entre les marges niçoise et corse vis-à-vis de l'alimentation détritique du bassin.

En conclusion, aux deux extrémités de la marge occidentale de la Corse, les matériaux détritiques terrigènes présents sur le glacis sont d'origine allochtone. Ils proviennent de la Provence pour la partie Nord et de la Sardaigne pour la partie Sud.

Contrairement à leurs équivalents de la façade orientale de la Corse, les apports de la Corse occidentale n'apparaissent pas, au niveau notamment de leurs parties distales, inscrits à l'intérieur de lobes sédimentaires morphologiquement bien délimités. Ces caractères reflètent les différences de configuration physiographique des deux bassins qui bordent l'île : à l'Ouest un bassin largement ouvert, à l'Est un bassin étroit et fortement structuré, barré par un système méridien de sillons et de dorsales.

Contribution n° 638 de l'URA CNRS 718.

REFERENCES

G. PAUTOT, G. BELLAICHE, J. R. VANNEY, J. P. REHAULT, et A. COUTELLE, 1992, Morphobathymétrie des marges de la Corse établie à l'aide d'un nouveau sondeur multifaisceaux à longue portée. C. R. Acad. Sc. Paris, t. 314, série II, 1992,, p. 603, 610.

G. BELLAICHE, L. DROZ, V. GAULLIER et G. PAUTOT, 1993, les appareils sédimentaires de la marge orientale de la Corse: interprétation hydrodynamique et implications structurales, C. R. Acad. Sci., Paris, série, II, t. 316, 1993, p. 513-517.

G. PAUTOT et G. BELLAICHE, 1993, Apport de la fonction "imagerie acoustique" du sondeur Simrad EM12D de l'Atalante sur la connaissance de la nature des fonds océaniques : prolongement du canyon du Var à l'Ouest de la Corse, C. R. Acad. Sci., Paris, série, II, t. 317, 1993, p. 663-670.

BELLAICHE G., DROZ L., GAULLIER V. et PAUTOT G., 1994, Les caractères morphologiques et sédimentaires du glacis de la Corse occidentale d'après les résultats de la campagne Mesea II-Mesim", C. R. Acad. Sc. Paris, t. 318, sér.II, p. 795, 802.

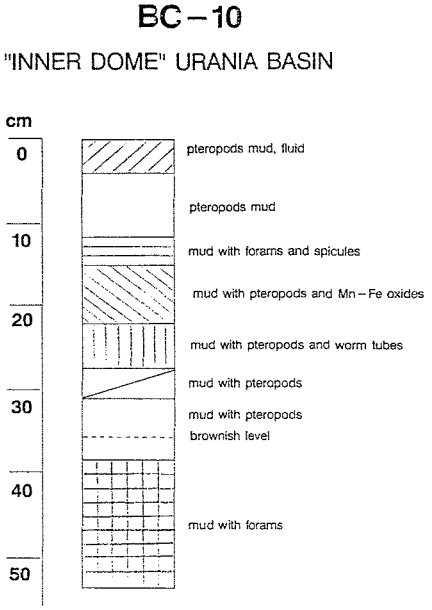
BELLAICHE G., DROZ L., GAULLIER V.et PAUTOT G., 1994, Small submarine fans on the eastern margin of Corsica : sedimentary significance and tectonic implications. *Mar. Geology*, 117 : 177-185.

THE BC10 BOX-CORE (PALEOFLUX CRUISE I) FROM THE "INNER DOME" AREA IN URANIA BASIN (EASTERN MEDITERRANEAN). PALEOCLIMATIC DATA FROM PTEROPOD ASSEMBLAGES

Simona BIANCHI and Cesare CORSELLI

Dipartimento di Scienze della Terra, Università degli Studi di Milano via Mangiagalli 34, 20133 Milano, Italia

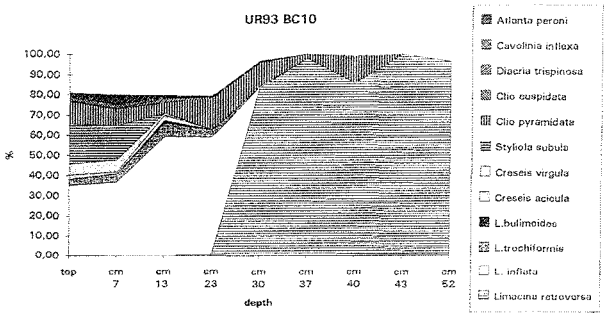
The distribution of twelve Pteropods species of box-core BC 10 from the Inner Dome (Urania Basin - Eastern Mediterranean) was analyzed quantitatively. The aim was to study the Pteropod assemblages in a pelagic sedimentary sequence where typical litologycal marker (sapropel) of the Pleistocene of eastern Mediterranean was not manifest. Box-core BC 10 was raised from the Inner Dome (Urania Basin Lat: 35°14'00" N Long: 21°30'23" E) at depth of 3382 m, during the Paleoflux Cruise I of the R/V Urania (September-October 1993). The box-core has a lenght of 55 cm. Pteropod mud is the dominant lithology (fig.1); a brownish millimetric level, and a strongly bioturbed level also occur. Quantitative analysis was carried out on nine samples, considering the size fraction larger than 250 μ.



For each sample, all Pteropod species were identified and respective specimens counted. The twelve species here considered as warm or cold water indicators are still living in the world oceans. Therefore, their ecology is rather well known, on account of studies on living populations. The planktonic species recorded in the present study have been subdivided as follows : 1) warm water indicators (*L. inflata, L. trochiformis, L. bulimoides, C. acicula, C. virgula, S. subula, C. cuspidata, D. trispinosa, C. inflexa*), 2) cold water indicators (*L. retroversa*), 3) cosmopolitan species (*C. pyramidata, A. peroni*).

The plot of relative frequency of warm water inndicators and cold water indicators was prepared. The composition of the pteropod assemblages and the proportion pertaining to different species of pelagic mollusc shells found in the box-core varies from top to bottom (fig. 2). The lower levels (cm 52, cm 43, cm 40, cm 37) yielded an association with cold water species, such as *L. retroversa* (sub-polar species, which today isn't in the Mediterranean sea) and *C. pyramidata* (eurythermic and euryaline species). This group of Pteropods seems to have characterized the end of Wurmian age (late Pleistocene). The upper levels (top and cm 7) contain an association of warm sub-tropical water species (*L. inflata, L. trochiformis, S. subula*) and warm tropical species (*C. virgula, C. acicula, C. inflexa*). This group of Pteropods seems to have characterized the recent age after the optimum climatic time. At 13 cm from the top the pteropod assemblage proves the optimum climatic time (about 8000 years B.P). This is supported by the presence of *L. bulimoides* (PASTOURET, 1970).

Usually, in the eastern Mediterranean, concomitant with of the optimum climatic time (about 8000 years ago) sapropel S-1 whose deposited. In the box-core here considered, at a stratigraphic level approximately coincident with the deposition of S-1, about cm 2 of grayish brown sediment are noted, which separate the upper brown pteropod mud from the lower light brownish gray pteropod mud. The lack of clear sapropelitic level can be related to biological activity or chemical diagenesis or both.



REFERENCES

PASTOURET L., 1970. Etude sédimentologique et paléoclimatique de carottes prélevées en Méditerranée orientale. *Téthys*, 2 (1) : 227-266

VAN STRAATEN L. M. J. U., 1972. Holocene stages of oxygen depletion in deep waters of the Adriatic Sea. *In* : The Mediterranean sea. A Natural Sedimentation-laboratory. Daniel J. Stanley Editor. pp. 631-643.

NEW METHODOLOGY TO DETECT PRIMARY CELLULAR RESPONSES AND EARLY SIGNS OF ENVIRONMENTAL PATHOLOGY AND CLASTOGENICITY IN MARINE BENTHIC COMMUNITIES

Vladimir BRESLER[1], Valentina YANKO[1] and Lev FISHELSON[2]

[1]Institute for Nature Conservation Research, [2] Department of Zoology, G.S. Wise Faculty of Life Sciences, Tel Aviv University, Ramat Aviv 69978, Israel

Detection of primary and secondary responses of living organisms to various environmental actions is the major problem of modern ecological toxicology. Since all normal and pathological responses start at molecular and subcellular level, they may be discovered by examination of molecular organization and properties of the main chemical cellular components (DNA, RNA, enzymes, carriers, second messengers, etc.) as well as supramolecular structures (nuclear chromatin, membranes, respiratory chain, chromosomes, etc.).

Compounds and structures that are involved in chemosensory responses or cellular defense, naturally enough, are of great value for this purpose. Over the past decade, studies that use molecular parameters as indicators of environmental health have been strongly intensified. However, many important general molecular defense mechanisms (i.e. carrier-mediated transport systems for xenobiotics' elimination, diffusion barriers, binding proteins and structures, some enzymes, activation or amplification of some gene locuses) are rarely used for this purpose. Unfortunately, the study of such indicators by using conventional methods is very labour-intensive and expensive.

Therefore, we developed a set of vital quantitative microscopic biophysical, cytophysiological, cytochemical and morphological methods as well as special devices that can expose both primary responses of eukaryotic cells to any environmental actions and early signs of environmental pathology and genotoxicity. Especially fluorescent contact microscopy allows to examine such integral cellular characteristics for populations and communities. Our studies were focused on examination of dominant species of benthic foraminifera and bivalve mollusks, that dwell along the Israeli Mediterranean shore. However, we also studied some other marine protists (i.e. gastropods and benthic fishes).

These studies discovered numerous defense mechanisms against xenobiotics in all investigated species and showed the importance of these mechanisms for survival and interactions between species and ecosystem stability. Members of benthic communities can affect the chemical composition and properties of their microenvironment and modify toxicity of some pollutants. The detected mechanisms, involved in adaptation and defense, can be used for early exposure of environmental stress (BRESLER and FISHELSON, 1994; BRESLER and YANKO, in press).

G

REFERENCES

BRESLER V., and FISHELSON L., 1994. Microfluorometrical study of benzo(a)pyrene and marker xenobiotics' bioaccumulation in the bivalve *Donax trunculus* from clean and polluted sites along the Mediterranean shore of Israel. *Disease of Aquatic Animals*, v. 19, 193-202.

BRESLER V. and YANKO V. Chemico-ecological approach to study of some benthic foraminifera. *J. Foram. Res.*, in press.

THE MCS PRISMED CRUISE, PART 1 : THE OUTER AND CENTRAL MEDITERRANEAN RIDGE

Eric CHAUMILLON[1], Jean MASCLE1, Hans Jürgen HOFFMANN[2] and Henrik Hove PEDERSEN[3]

[1] GEMCO, Lab. de Géodynamique Sous-Marine, B.P. 48, 06230 Villefranche/mer, France

[2] GEOMAR, Wischofstrasse 1-3, 24148 Kiel, Germany

[3] Geosciences, Aarhus Universität,8000 Aarhus, Denmark

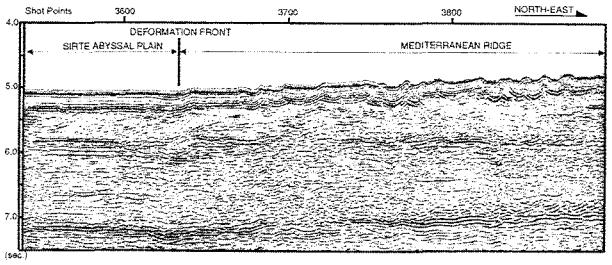
In eastern Mediterranean, the Mediteranean Ridge (M.R.) consists of a huge pile of accreted sediments in response to the convergent motions between the African, European and Aegean plates respectively. The multichannel seismic reflection Primed cruise (March 1993) has provided new images of internal deformations occurring within this specific pre-collisional sedimentary wedge.

1 - Between the Sirte abyssal plain and the western Hellenic trench area, the occurence of southward-directed thrusts, northward-directed back-up thrusts as well as the presence of a well evidenced decollement level clearly substantiate the accretionnary mechanism at the origin of the MR. Messinian evaporitic layers likely play the major part within the MR recent deformation history.

2 - South of Crete and facing the undeformed continental margin and Lybian promontory, the outer MR is chiefly expressed by an highly deformed wedge of sediments bounded by steep and rather irregular slope. Messinian sediments are also clearly involved in the tectonic accretion processes. In this area the central M.R., characterized by mud diapiric activities, is bounded, both northward and southward, by major thrust zones.

3 - In its eastern sector, facing the thickly sedimented Herodotus abyssal plain, the MR deformation outer front is characterized by steep reverse faulting and associated wide anticlines and accompanying piggy-back basins. There, the central M.R. exhibits large wave-lenght folding and is bounded, on its northward side, by major back thrust features.

The dominant factors that seem to control the present day M.R. structural styles relate to the nature and thickness of, both, the sedimentary cover and crust of the subducting forelands. The maximum shortening characterizes the central M.R. domain clearly directly involved in collisional processes against the Lybian promontory.



The M. R. outer deformation front facing the Sirte abyssal plain

STRATIGRAPHY AND SEDIMENTATION IN THE MEDITERRANEAN RIDGE DIAPIRIC BELT

M. B. CITA[1], E. ERBA[1], R. LUCCHI[2], M. POTT[3], R. V. D. MEER[3] and L. NIETO[4]

[1] Dipartimento di Scienze della Terra, Università degli Studi di Milano via Mangiagalli 34, 20133 Milano, Italy

[2] Department of Geology, University of Wales, College of Cardiff, P.O. Box 914, Cardiff CF1 3YE, United Kingdom

[3] Faculty of Earth Sciences, Free University, De Boelelaan 1085, 1081 HV Amsterdam, the Netherlands

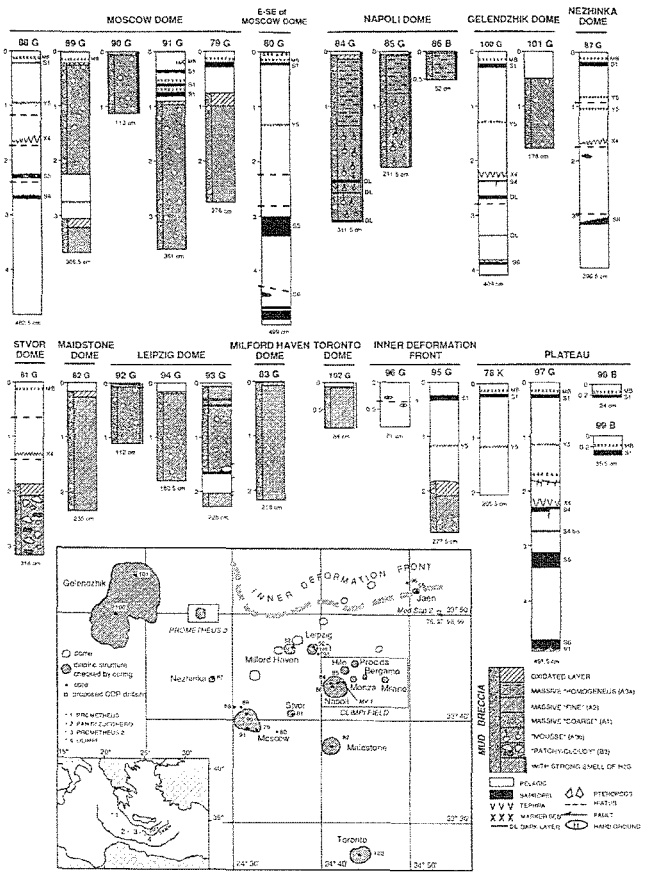
[4] Department of Geology, University of Jaén, Paraje las Lagunillas, 23071 Jaén, Spain

Two basic sediment types are recorded in the Mediterranean Ridge diapiric belt: the host sediment and the mud breccia. The host sediment consists of hemipelagic marl as dominant lithology, associated with sapropels and tephras as minor isochronous lithologies. A high resolution stratigraphy, which allows much more detailed and precise correlations than those based on biostratigraphy (essentially calcareous nannofossils) is applicable to the over 20 cores considered in this study, that were obtained during cruise TTR3-Leg 2 in 1993.

The mud breccia is matrix-supported and contains submillimetric to pluricentrimetric clasts in various amounts, up to 50% (STAFFINI *et al.*, 1993). This lithology is consistently related to doming physiographic features of different size and shape (CAMERLENGHI *et al.*, 1992), and to high reflectivity patches recorded on long range side-scan sonar.

The mud breccia can be intruded or extruded. The massive, coarse nature of the mud breccia recorded in the large majority of the 16 cores that contain this lithology suggests intrusion. Cores from Napoli Dome, which is typically an active mud volcano (CITA *et al.*, in press), are fine-grained and very gaseous. Contacts between the mud breccia and the host sediment are mostly distinct, but may be gradational. Two cores document interlayering of the mud breccia with pelagic sediments, but no turbidites were ever recovered.

Among the main results of the study we mention: the strong slope instability documented by the pelagic host sediments from the ridge diapiric belt (hiatuses, microfaults, hard grounds); the wide distribution of diapiric features across the ridge axis (from the Inner Deformation Front to the Toronto Dome, some 50 km to the south); the age of the mud breccia (matrix essentially) which is consistently early-middle Miocene with some older elements, but is strictly mid Cretaceous for the southermost Toronto Dome.



REFERENCES

CAMERLENGHI A., CITA M. B., HIEKE W. and RICCHIUTO T., 1992. Geological evidence for mud diapirism on the Mediterranean Ridge accretionary complex. *Earth Planet. Sc. Letters*, 109 : 493-504.

CITA M. B., WOODSIDE J. M., IVANOV M. K., KIDD R. B., LIMONOV A. F. and scientific staff of Cruise TTR3-Leg 2, in press. Fluid venting, mud volcanoes and mud diapirs on the Mediterranean Ridge. Acc. Naz. Lincei, Rend. Cl. Sc. Fis. Mat. Nat.

STAFFINI F., SPEZZAFERRI S. and AGHIB F., 1993. Mud diapirs of the Mediterranean Ridge: sedimentological and micropaleontological study of the mud breccia. *Riv. It. Paleont. Strat.*, 99, 2 : 225-254.

LE VOLCANISME DU SUD DE LA MÉDITERRANÉE OCCIDENTALE ET SA PLACE DANS LA TECTOGENÈSE ALPINE

Alain COUTELLE

URA du CNRS n° 1278, Département des Sciences de la Terre, U.B.O. B.P. 809 29285 Brest, France

La présence de volcans sur les rives de la Méditerranée occidentale est un fait bien connu. Le Vésuve, l'Etna, le Stromboli sont célèbres à divers titres et pas seulement géologiques. Ils témoignent d'une activité actuelle, qui prolonge un dynamisme plus ancien et de plus grande extension. En effet, à part les îles Baléares et la Corse, où ces manifestations ne sont pas connues, on trouve des affleurements de matériel volcanique cénozoïque sur tout le pourtour de la mer. Il en existe aussi en mer, directement échantillonnées par plongées ou dragages ou seulement repérées par aéromagnétisme.

Ce magmatisme est très varié, tant par ses gisements que par son chimisme, puisqu'on y reconnaît des séries calco-alcalines, shoshonitiques et alcalines. Les anciens auteurs l'ont toujours considéré comme essentiellement récent et postérieur aux phases alpines majeures, statut que les travaux de terrain suivants lui ont conservé, même au travers de révisions importantes concernant l'âge et le style des déformations.

A partir de 1971, l'application aux maghrébides du modèle tectonique des arcs insulaires va mettre en cause cette manière de voir. En effet, dans cette conception, la déformation n'est pas concentrée sur un petit nombre de phases courtes et intenses mais étendue sur toute la période d'expression du dispositif paléogéographique pendant lequel fonctionne la subduction, génératrice du volcanisme.

Le point fort de ce modèle résidait dans le type même du volcanisme, qui n'est actuellement reconnu que dans les seuls arcs insulaires. Les autres arguments, d'ordre paléogéographique et tectonique, moins contraignants, provenaient d'un choix parmi les diverses hypothèses admises à l'époque. La poursuite des travaux a montré la grande improbabilité géométrique des subductions récentes supposées par le modèle, et confirmé qu'il y a bien séparation dans le temps et dans l'espace du volcanisme et de la tectonique majeure alpine. Comme il faut quand même rendre compte de la nature calco-alcaline du volcanisme littoral d'Afrique du Nord, on peut admettre (provisoirement ?) que celui-ci est lié à d'anciennes contaminations magmatiques révélées à la faveur de la fracturation des domaines autochtones périalpins.

Dynamiquement, ce magmatisme n'est donc pas à rapprocher de la tectogenèse alpine. Il faut plutôt y voir la manifestation superficielle d'une activité profonde, caractéristique des bordures autochtones du dispositif et probablement liée aux processus d'océanisation tardi-tectonique à l'origine des actuels bassins de la Méditerranée occidentale.

G

THE "MARKER - BED" OF THE MEDITERRANEAN RIDGE DIAPIRIC BELT

Luisa DE CAPITANI and Maria Bianca CITA

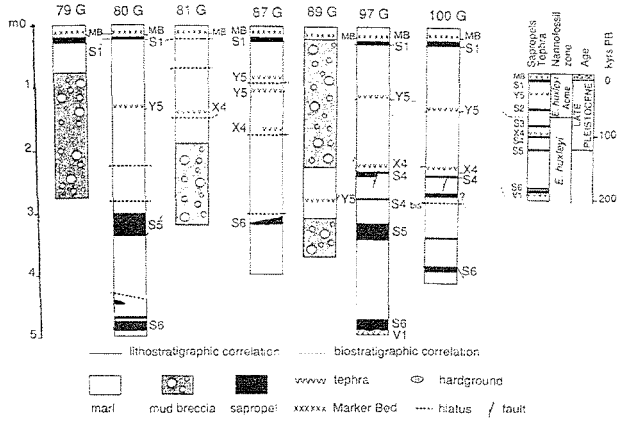
Department of Earth Sciences, University of Milan, Italy

A prominent marker-bed, jet black in colour, with a sharp basal contact and centimetric thickness, is ubiquitous in the Mediterranean Ridge crestal area, where collision between the European plate and the African plate occurs, and mud diapirism is a common phenomenon (CITA *et al.*, 1989; CITA and CAMERLENGHi, 1992; CAMERLENGHI *et al.*, 1992).

The marker-bed is consistently recorded in the upper part of the sediment cores, within the Holocene pteropod-foraminiferal oozes, above sapropel S-1, which documents the last, youngest, postglacial stagnant episode recorded in the eastern Mediterranean.

The marker-bed consists of numberless Mn micronodules of bacterial origin (CITA *et al.*, 1989) and presents an abnormal concentration of metals, with Mn reaching up to 22% in weight (CITA and DE CAPITANI, 1994). The same technique was used for the present investigation, analyzing three samples per core, one taken a few cm below the marker-bed, one within it, the third one above.

Of the 25 cores, recovered during the Gelendzhik 1993 Cruise TTR 3-Leg2, 12 contained the marker-bed, but 13 did not. The large majority of the latters (10) consisted of extruded mud breccia up to the core top and one consisted of pre-Holocene sediment. Eight cores of the 12 containing the marker-bed had a pelagic make up, the remaining ones contained the diapiric mud-breccia of deep provenance (see Fig.1). Seven cores were investigated geochemically in their elemental composition. The results are presentad in Table 1. The new results confirm and support the previous ones, and record percentages of Mn within the marker-bed ranging from 2.98 to 16.12%, values that exceed by at least one order of magnitude those of the adjacent layers, suggesting an origin independent from the local environment and dependent to fluid flow from the accretionary prism.



samples	Mn wt %	Fe wt %	Cu ppm	Ni ppm	Co ppm
79G -11	0.34	1.88	46	82	8
79G -15 MB	16.12	1.75	176	76	29
79G - 18	0.34	2.62	48	126	16
80G - 10/11	0.25	1.98	40	76	8
80G - 12/14 MB	8.79	2.08	103	49	23
80G - 14/16	0.21	2.98	44	117	19
81G - 7/8	0.12	1.95	36	68	8
81G - 12/13 MB	3.36	2.46	60	55	17
81G - 17/18	0.22	3.59	56	109	17
87G - 6/7	0.10	1.91	40	72	8
87G - 9/10 MB	4.71	1.86	80	59	18
87G - 11/12	0.19	2.18	44	106	13
89G - 1 above	0.49	2.04	42	82	9
89G - MB	4.14	2.30	313	164	14
89G - 1 below	0.17	2.60	44	100	18
97G - 9/11	0.09	2.05	46	83	10
97G - 14/16 MB	2.98	2.18	75	70	13
97G - 18/20	0.34	2.85	44	158	20
100G - 11/12	0.07	1.92	34	66	7
100G - 15/17 MB	3.17	2.11	104	99	10
100G - 20/21	0.30	3.02	50	130	17

REFERENCES

CITA M. B., CAMERLENGHI A., ERBA E., MCCOY F. W., CASTRADORI D., CAZZANI A., GUASTI G., GIAMBASTIANI M., LUCCHI R., NOLLI V., PEZZI G., REDAELLI M., RIZZI E., TORRICELLI S. and VIOLANTI D., 1989. *Boll. Soc. Geol. It.*, 108, 537-543.

CAMERLENGHI A., CITA M. B., HIEKE W. and RICCHIUTO T., 1992. *Earth Planet. Sc. Lett.*, 109 : 493-504.

CITA M. B. and CAMERLENGHI A., 1992. *Mem. Soc. Geol. It.*, 45 : 436-480.

CITA M. B. and DE CAPITANI L., 1994. *Boll. Soc. Geol. It.*, 113 : 25-35.

HEAT FLOW MEASUREMENTS ON THE MEDITERRANEAN RIDGE INDICATE TRANSIENT PROCESSES OF HEAT TRANSFER BETWEEN THE SEDIMENTS AND THE WATER COLUMN (MAST II - MEDRIFF PROJECT)

B. DELLA VEDOVA, J.-P. FOUCHER, G. PELLIS, F. HARMEGNIES and the MEDRIFF Consortium*

We present the results of 120 conventional heat flow density (HFD) measurements with *in-situ* determination of the thermal conductivity, collected across the Mediterranean Ridge (MR), from the Jonian abyssal plain to the Matapan Trench, during the Urania, Discovery and Le Suroit cruises undertaken from September 1993 to June 1994. The investigations are part of the 3-year multidisciplinary MAST II-MEDRIFF (An Integrated Investigation of the Fluid Flow Regime of the Mediterranean Ridge) research project funded by the Commission of the European Communities.

The HFD measurements in the sediment were complemented by 7 CTD profiles which provided information on the thermal structure of the water column and were used to calibrate the absolute temperature readings of the heat flow probes. Temperature and pressure data of the heat flow probes were then used to integrate the CTD data in the water column and to provide reliable temperature profiles in the brines of the newly discovered Urania and l'Atalante brine lakes, located on the MR Inner Plateau, WSW of Crete.

Temperature data in the l'Atalante and Urania brine lakes indicate that both lakes are thermally stratified. Three layers with temperature slightly lower than in the sea bottom water were identified in the l'Atalante basin. Contrasting with these low temperatures of the l'Atalante basin, temperatures up to 29°C were measured in the bottom layer of the Urania lake, which suggest active or very recent inflow of warm brines into this lake. We discuss some of the implications of the thermal data in terms of the source and nature of the brine lakes.

A puzzeling observation made outside the brine lakes is that the temperature profiles in the sediment show strong negative curvatures, i.e. the shallow sediments are cooler than the sea bottom water. We relate the occurrence of the observed curvatures to the effects of bottom water temperature flactuations which propagate into the sediments by conductive heat transfer. The effects are spectacular in the corridor, about 150 km long, which extends from the Matapan trench to the MR crestal area, where temperature gradients remain conspicuously negative to depths of 3-5 meters in the sediments.

Fig. 1 shows the temperature distribution with depth in the sediments along HFD_1 profile (57 measurements), which is 70 km long and crosses the MR summit area and the adjacent part of the Inner Plateau. The temperature at the sea floor is generally increasing from the MR summit area towards the deeper Inner Plateau.

We discuss some implications of the thermal data in terms of source and nature of the thermal transient in the shallow sediments of the MR.

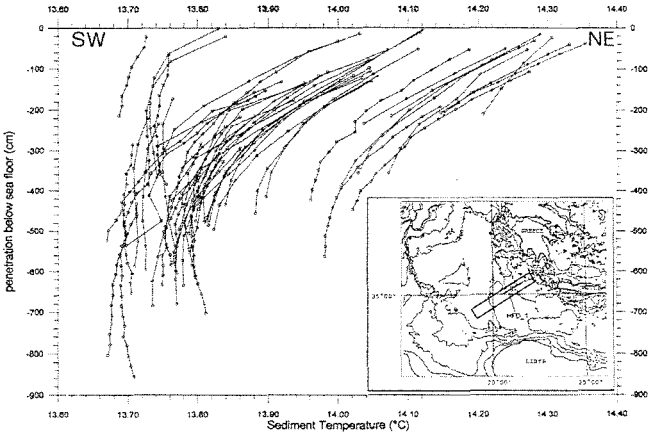


Fig. 1. Temperature distribution in the few upper meters of sediment along HFD_1 profile across the MR. Positioning of the MEDRIFF corridor and of the HFD_1 profile are indicated in the inset map.

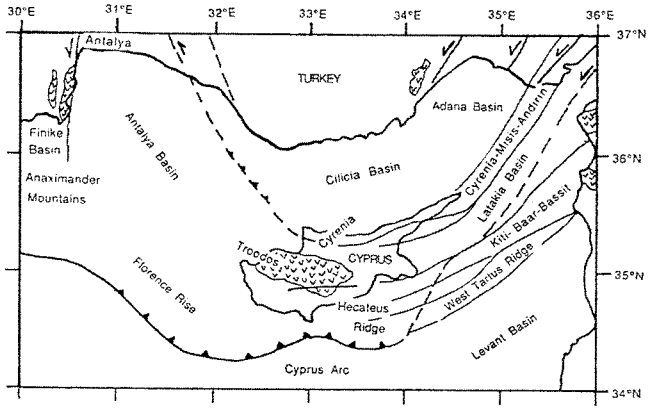
* MEDRIFF Consortium :
G.K. Westbrook, R.F. Woollett, School of Earth Sciences, Univ. of Birmingham, England,
X. Le Pichon, S. Lallemant, N. Chamot-Rooke, Laboratoire de Géologie, Ecole Normale Supérieure, Paris, France,
J.-P. Foucher, F. Harmegnies, IFREMER/Centre de Brest, France,
E. Suess, A. Bleyer, GEOMAR Forschungszentrum für Marine Geowissenschaften, Christian Albrechts-Universität Kiel, Germany,
H. Villinger, Fachbereich Geowissenshaften, Universität Bremen, Germany,
B.M. Cita, N. Fusi, G. Aloisi, Dipartimento di Scienze della Terra, Università di Milano, Italy,
A. Camerlenghi, A. Polonia, Osservatorio Geofisico Sperimentale, Trieste, Italy,
B. Della Vedova, G. Pellis, Dipartimento di Ingegneria Navale, del Mare e per l'Ambiente, Università di Trieste, Italy,
L. Mirabile, V. Severino, Istituto Universitario Navale, Napoli, Italy,
P. Pavlakis, M. Alexandri, National Centre for Marine Research of Greece, Athens, Greece.

CYPRUS BACK-ARC BASINS IN THE NORTHEASTERN MEDITERRANEAN

Mustafa ERGÜN

Dokuz Eylül University, Faculty of Engineering, Department of Geophysics 35100 Bornova-Izmir, Turkey

The present-day tectonic framework of the eastern Mediterranean is controlled by the last phase of collision between the African and Eurasian plates. The Agean/Anatolian plate is pushed westwards along strike-slip faults, due to collision between the Arabian/Syrian and Eurasian plates along the Bitlis-Zagros Suture. 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 systems 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, Antalya and East Anatolian fault zones (including the Amanos and Ecemis Faults) are sub-parallel to the slip vector, with predominantly transform motion.



Tectonic framework of the northeastern Mediterranean and the Cyprus back-arc basins.

The eastern Mediterranean includes several distinct provinces, the formations of which are intimately related to the histories of the provinces in the regions of plate convergences. The Cenozoic depocentres along the southern margin of the Anatolian plate which is located in the back-arc setting on an active orogenic region with complicated microplate configuration. The edge of the Anatolian platform, immediately southwest of the Africa/Arabia/Anatolia triple junction, and includes four genetically related basins : Adana, Cilicia, Iskenderun and Latakia Basins. These four basins collectively form a moderately large semi-enclosed depocentre in the northeastern Mediterranean sea. The Antalya basin, which is surrounded by Anaximander Mountains and Beydaglar range in the West and Florence Rise in the South, is again one of the principal late depocentre between the northwest of Cyrus and southern Turkey. The Cilicia basin lies in between these two main basinal areas. The Misis-Kyrenia fault zone links the Misis Mountains of southern Turkey and Kyrenia range of northern Cyprus.

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 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. 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. Northward from the Florence rise, passing into the Antalya basin which is is actively sinking and tilting to the northeast, the concordance of the Messinian reflectors with the overlying sediments is maintained, but the sabement of the Messinian appears tilted northwards and folding effects the entire succession. The sinistral strike-slip fault of Antalya has a great implication on the Antalya ophiolites and emplacement of the Anaximander Mountain block. This thrust zone also affects the Messinian salt layers creating cobblestone structures.

REFERENCES:

AKSU A. E., ERGÜN M., HALL J. M., DUMAN M. Y., YASAR D. and CALON T., 1992. Tectonic evolution of basins in the northeastern Mediterranean sea, (abstract), Yerbilimleri, *Bull. Earth. Sci*, 20 : 352-353.

BIJU-DUVAL B., LETOUZEY J., and MONTADERT L. 1979. Variety of margins and deep basins in the Mediterranean. *In* : J.S. Watkins L., Montadert and P.W. Dickerson (eds.), Geological and Geophysical Investigations of Continental Margins, AAPG Memoir 29, p 293-318.

EVANS G. P., EVANS W. E., EVANS T. R. and WOODSIDE J. M., 1978. Faulting and helokinetics in the northeastern Mediterranean between Cyprus and Turkey. *Geology*, 6 : 392-396.

DISTRIBUTION OF MUD DIAPIRISM AND OTHER GEOLOGICAL STRUCTURES FROM LONG-RANGE SIDE-SCAN SONAR (GLORIA) DATA, IN THE EASTERN MEDITERRANEAN SEA

Nicoletta FUSI[1] & Neil H. KENYON[2]

[1] Dipartimento di Scienze della Terra, Universita' degli Studi di Milano, via Mangiagalli 34, 20133 Milano, Italy

[2] Institute of Oceanographic Sciences, Wormley, Surrey, GU85UB, United-Kingdom

Extensive long range sidescan sonar coverage, obtained with the GLORIA system in the eastern Mediterranean eea, has been reinterpreted in the light of subsequent "ground truth" data. Several types of high back-scattering patches are recognized.

About 150 circular to sub-circular patches have been identified on the shallower and inner part of the Mediterranean Ridge accretionary complex. Some can occur in groups or in ridge parallel alignments, associated with deep-seated structures (KENYON *et al.*, 1982). On the basis of core stratigraphy they have been interpreted as mud volcanoes and mud ridges, with surface or near surface mud breccia (CAMERLENGHI *et al.*, 1992). It seems that mud volcanoes are not imaged by the 6.5 kHz GLORIA system if there is a cover of more than about 2 m of pelagic sediments. Few high back-scattering patches are present in these external parts of the Calabrian and Cyprus arcs that have been surveyed. It is thus confirmed that mud diapirism is more common where the covering Messinian salt is thinner; this occurs on the crest and inner part of the Mediterranean Ridge (CAMERLENGHI *et al.*, in press).

Larger, more elongated patches, up to 80 km long and usually associated with steep slopes, are found in the Hellenic Trough System; they are attributed to hard rock outcrops (HUCHON *et al.*, 1982). Similar shaped patches, associated with lower relief, found near the eastern and western ends of the Mediterranean Ridge, are attributed to dissolved evaporites at the top of salt diapirs which leave a rough, karst like surface topography. Other elongate patches of high backscatter at the foot of the Nile Cone may be due to differences in grain size and/or to chemical crusts; they are on diapiric fold crests that are probably due to salt mobilisation (SMITH, 1976). A few small circular patches, found at the foot of scarps on the Nile Cone, are attributed to debris flow deposits.

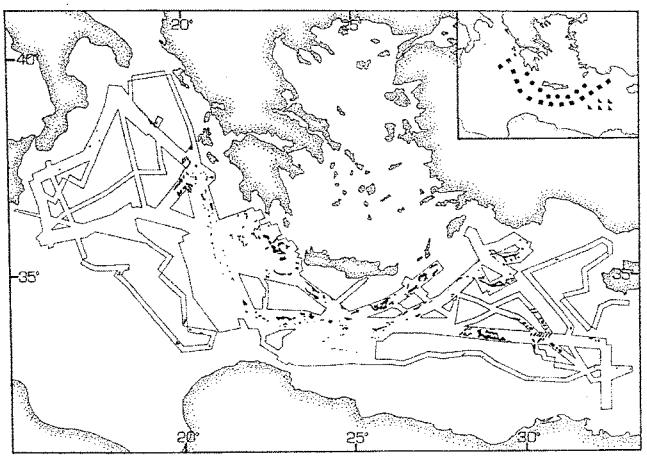


Fig. 1 - Distribution of high back-scattering patches within the GLORIA coverage. Inset: dots = Hellenic Trough, squares = Mediterranean Ridge, triangles = Nile Cone.

REFERENCES

CAMERLENGHI A., CITA M. B., HIEKE W. and RICCHIUTO T., 1992. Geological evidence for mud diapirism on the Mediterranean Ridge accretionary complex. *Earth Planet. Sc. Letters*, 109 : 493-504.

CAMERLENGHI A., CITA M. B., DELLA VEDOVA B., FUSI N., MIRABILE L. and PELLIS G., in press. Geological evidence for mud diapirism on the Mediterranean Ridge accretionary complex. *Mar. Geophys. res.*

HUCHON P., LYBERIS N., ANGELIER J., LE PICHON X. and RENARD V., 1992. Tectonics of the Hellenic Trough : a synthesis of sea-bream and submersible observations. *Tectonophysics*, 86 : 69-112.

KENYON N. H., BELDERSON R. H. and STRIDE A. H., 1982. Detailed tectonic trends on the central part of the Hellenic Outer Ridge and in the Hellenic Trough system. *In* : J. K. Legett (Ed.), Trough forearc geology : sedimentation and tectonics on modern and ancient active plate margins. Spec. Publ. Geol. Soc. London, 10 : 335-343.

SMITH S. G., 1976. Diapiric structures in the eastern Mediterranean Herodotu basin. *Earth Plant. Sci. Letters*, 32 62-68.

G

STRUCTURAL FEATURES OF MUD VOLCANOES AND FOLD SYSTEM OF THE MEDITERRANEAN RIDGE, SOUTH OF CRETE

Jesùs GALINDO-ZALDIVAR[1], Luis NIETO[2] and John WOODSIDE[3]

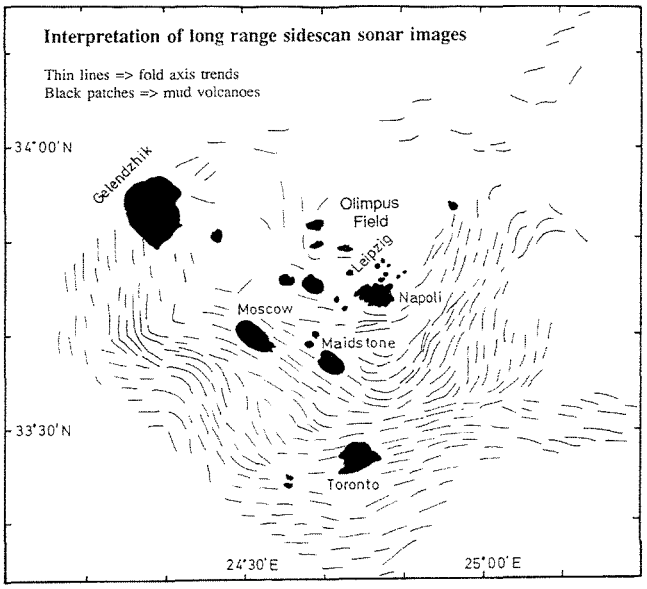
[1] Departamento de Geodinámica, Universidad de Granada, 18071 Granada, España
[2] Departamento de Geologia, Universidad de Jaén, Campus Universitario 23071 Jaén, España
[3] Faculty of Earth Sciences, Free University, De Boelelaan 1085 081 HV Amsterdam, The Netherlands

New information about the geometry of mud volcanoes, folds, and fractures located in the central part of the Mediterranean Ridge is provided by images from long-range and deep-towed sidescan sonar systems, profiles from high resolution seismic and deep-towed subbottom profiler, and by gravity cores obtained during the 1993 UNESCO-ESF Training Through Research cruise of R/V Gelendzick. Mud volcanoes are formed by domes of intercalated pelagic sediments and mud breccias containing clasts as old as Upper Cretaceous. The mud breccias are extruded mainly from point sources, although some fissural emissions are also observed. Mud volcanoes have an irregular to elliptical shape with diameters up to 16 km. The distribution of the mud volcanoes in the area is irregular, but there appear to be local concentrations along the ridge crest. Our survey was restricted to the area around the Olimpi Field.

The Pliocene-Quaternary sediments in this area, and probably also the Messinian sediments, are deformed by symmetrical very open folds, with mean wavelength of 750 m. The hinge lines of the folds are curved around the area where the mud volcanoes are concentrated. Some of the folds show an intrusive nucleus and, in some cases, mud breccia is inferred from the sidescan sonar images to be flowing from the limbs of the folds into the synclinal areas in between.

Fractures in the uppermost part of the Mediterranean Ridge are rare. Most of the faults are normal and subparallel to fold limbs. Furthermore, subvertical fractures with orientations of N20E and N100E are found controlling the shape of the mud volcanoes.

In most areas of the Mediterranean Ridge, fold hinge lines are subparallel to the elongation of the ridge. In the study area, however, mud volcano emplacement may modify the regional stress and strain field related to the NNE-directed subduction of the African plate below the Eurasian plate along the Hellenic arc, resulting in the arcuate fold system observed. Elongated mud volcanoes can grow from anticlinal folds. In the first stages, mud breccia intrudes the axis of the folds, and later, flows of mud breccias develop where the sides of the anticlines are breached.



STRESSES AND CRUSTAL STRUCTURE IN THE NORTHERN BOUNDARY OF THE ALBORAN SEA

GALINDO-ZALDIVAR J., ALDAYA F., GONZALEZ-LODEIRO F. and JABALOY A.

Departamento de Geodinamica, Universidad de Granada, 18071, Granada, Spain

Alpine deformation in the Betic-Rif Cordilleras and in the Alboran sea is active up to today. The present-day boundary between the Euroasiatic and African plates is located in this region. This boundary is not sharp, and it is composed by a broad band of distributed deformation and seismicity in the Betic-Rif Cordilleras and in the Alboran sea.

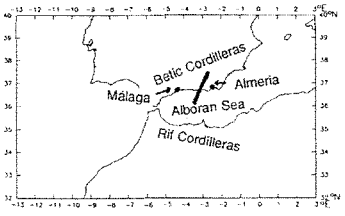
The NW-SE convergent character of this boundary produce a progressive decrease in the size of the Alboran sea from Neogene up to present times. The marine neogene sediments that crop-out in the internal basins of the Betic Cordilleras show that most of the uplift of the Internal zones was made in Miocene to present-day times. Simultaneously, the Alboran sea underwent subsidence.

The analyses of the earthquake focal mechanisms allow to determine the present-day stresses. Around the Betic-Rif Cordilleras, the maximum compressive stress is nearly horizontal and has a NW-SE direction, related with the convergence in the same direction of the Euroasiatic and African plates. In the external zones of the Betic Cordilleras, the maximum compressive stress has a low plunge toward the NW. In the internal zones of the Betic Cordilleras and in the Alboran sea, the stresses are very similar and show an extensional setting. The extension is variable in character, from radial extension in the Alboran sea and in the Malaga region, with the maximum compressive stress nearly vertical or highly inclined towards the NW, up to triaxial extension in Almeria region.

The field analysis of Neogene to Quaternary brittle deformations shows that the paleostresses were generally compressional in the external zones of the Betic Cordilleras, with a NW-SE compression direction, and extensional in the internal zones that constitute the basement of the Alboran sea during the Neogene.

The deep reflection seismic profiles in the Betic Cordilleras and the gravimetry data allow to determine the structure of the crust in the boundary between the Betic Cordilleras and the Alboran sea in the region between Malaga and Almeria. The gravimetric model across this area (Fig. 1.) shows that the boundary between the thick crust of the Betic Cordillera and the thin crust of the Alboran sea is located in a zone near the coast line. In this zone, the Moho dip is very high. The gravimetric data show that this boundary is located along a narrow band, E-W oriented and parallel to the coast line between Malaga and Almeria.

The crustal structure and the recent deformations in the northern boundary of the Alboran sea, mainly in the region between Malaga and Almeria, can be related to the convergence between the Eurasian and African plates. The movement towards the SE of the Iberian crust below the Internal Zones of the Betic Cordilleras, as a consequence of the plate convergence, probably cause the southward migration of the Alboran sea boundary during the Neogene to the present-day, and the progressive closing of the Alboran sea. The crustal thickening in this region produce a fast isostatic uplift of the internal zones of the Betic Cordilleras. In this setting, there are extensional stresses in the uppermost areas (internal zones) and compressional stresses in the deep and in the frontal areas of the Cordillera.



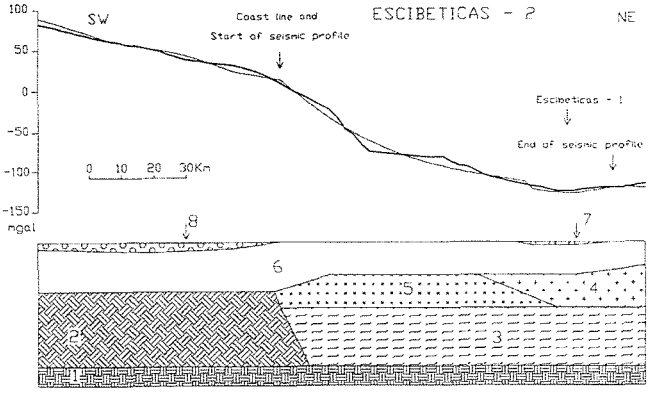


Figure 1. Gravimetric model of the ESCIBETICAS-2 profile (N30°E) where N90°E elongate infinite bodies are taken into account: 1, Upper mantle; 2, Anomalous upper mantle (3.21 g/cm^3); 3, Lower crust (2.89 g/cm^3); 4, Northern upper crust (2.80 g/cm^3); 5, Southern upper crust (2.78 g/cm^3); 6, Internal Zones of Betic Cordilleras (2.72 g/cmv); 7, Neogene basins (2.45 g/cm^3); 8, Sediments and sedimentary rocks of the Alboran sea (2.20 g/cm^3). Thick line: observed gravity profile. Thin line: calculated gravity profile.

THE ALGERIAN OFFSHORE EXPLORATION

A. HADAOUI

SONATRACH, Division Exploration, 2, rue de Cap. Azzoug, Hussein-Dey, Alger, Algérie

SONATRACH, a state oil company, began seismic exploration of the Algerian offshore and the western Mediterranean sea by the end of 1960, in three different and main steps.

In the first step, 1968 - 1970, the seismic profiling was concentrated on the bays along the Algerian coast longer than 1200 km. The main objective of this step was to define, as well as possible, the bathimetric data previously recorded and where it is, to some extent almost inexistant in front of the coastal chains.

For the second step, 1973-1974, the exploration idea became broader and then a very large exploration scale seismic programm was conducted. It includes the whole western Mediterranean sea, comprising Algero-provençal and Alboran basins. This survey allowed us to have a global morphology of the western Mediterranean sea, the thickness and the importance as well as the sedimentation and water depth.

Later, on 1976 - 1977, according to the results of the previous surveys, SONATRACH in association with TOTAL - CFP, recorded two important seismic programs in the western and eastern parts of the Algerian continental margin.

The result of the western program ended by a well drilled under 923 m of water and reached the metamorphic basement at 4418 m.

From that well, the lithostratigraphy of the western offshore was well defined and where the oldest deposits were dated of the upper - Miocene (TORTONIAN).

As concern the eastern offshore, no more works after the seismic survey in 1977, except reprocessing trials of a very few lines wich gave satisfying results.

Since that time, all the exploration efforts made in Algeria were concentrated on the continental domain, particularly on the Saharan platform.

MESSINA AND SIRTE ABYSSAL PLAINS AS FORELANDS OF THE MEDITERRANEAN RIDGE ACCRETIONARY COMPLEX

W. HIEKE[1], H. HIRSCHLEBER[2], A. DEHGHANI[2], J. HARTMANN[2]

[1] Technische Universität München, Lehrstuhl für Geologie, Lichtenbergstr. 4
85747 Garching, Germany

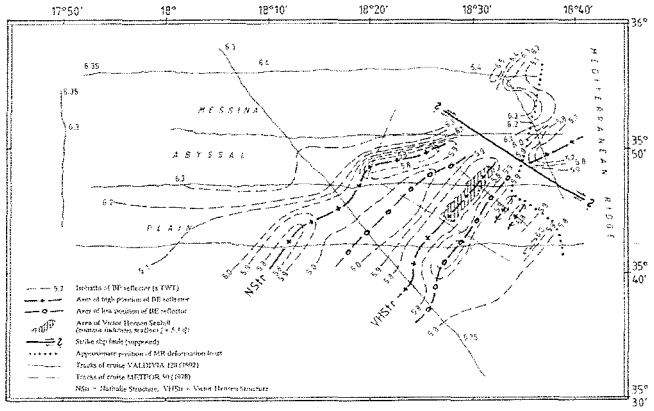
[2] Universität Hamburg, Institut für Geophysik, Bundestr. 55
20146 Hamburg, Germany

Only the Plio-Quaternary section of the sedimentary sequence of the Messina A.P. is known from DSDP Site 374 and several piston cores (HSÜ, MONTADERT *et al.*, 1978; HIEKE, 1984). The Quaternary is dominated by turbidites (MÜLLER *et al.*, 1978), the Pliocene by hemipelagic sediments. The occurrence of Upper Miocene (Messinian) evaporites is proved in Site 374. Information on older parts of the sedimentary sequence as well as on most of tectonic features is available from seismic investigations, e.g. carried out during Valdivia cruise 120 (HIRSCHLEBER *et al.*, 1994). Additional data come from gravity and magnetic studies.

The most important result is that the Messinian evaporites do not occur as a uniform thick layer covering the whole area under the Messina A.P. This is particularely documented in the SE corner of the plain. There Victor Hensen Seahill rises above the plain floor (HIEKE and WANNINGER, 1985). It is part of a narrow elongated SW-NE trending subbottom structure towards which the Messinian evaporites pinch out on both sides. Similar structures of different size accompany Victor Hensen Structure (Fig.). They are obviously affected by transverse faults. All structures are interpreted as horsts acting at least since Messinian time. Victor Hensen and Nathalie Structures are still active. The also observed pre-Messinian tectonics differ in size and type.

The pattern of syn- and post-Messinian tensional tectonic features is situated just in front of the about N-S trending deformation front of the Mediterranean Ridge accretionary complex. Therefore, we have to expect that similar structures influencing the thickness (and nature) of Messinian evaporites also occured in those part of the former Messina A.P. which are already incorporated into the accretionary complex. This can be confirmed by the relief of the ridge near the deformation front. Similar but less prominent structures are observed from Sirte A.P. There is most spectacular a synsedimentary normal fault displacing the base of evaporites in the order of 0.5 s TWT.

Decollement levels needed for shortening the sediment pile during accretion processes may have developped within the evaporite sequence as has been often assumed in the literature. Existing seismic profiles are not necessarely representative. Since the nature of the evaporites (with or without salt) is not yet known, and it is rather unlikely that evaporites cover as a uniform layer the whole area of the Mediterranean Ridge according to structural patterns of the incoming sediments like the presented one, we have to think about alternatives of the above mentioned level of main decollement.



The data of Valdivia cruise n°120 (this paper) are completed by data of Avedik and Hieke (1981) and Hieke and Wanninger (1985)

REFERENCES

HIEKE W., 1984. A thick Holocene homogenite from the Ionian Abyssal Plain (Eastern Mediterranean). *Mar. Geol.*, 55 : 63-78.

HIEKE W. and WANNINGER A., 1985. The Victor Hensen Seahill (central Ionian Sea) - morphology and structural aspects. *Mar. Geol.*, 64 : 343-350.

HIRSCHLEBER H. B., HARTMANN J .M. and HIEKE W., 1994. The Mediterranean Ridge accretionary complex and its forelands - seismic reflection studies in the Ionian Sea. *In* R. Ansorge (ed.), Universität Hamburg 1994. Schlaglichter der Forschung zum 75. Jahrestag. Hamburger Beiträge zur Wissenschafts. geschichte, vol. 15, Reimer-Verlag Berlin/ Hamburg, 491-509.

HSÜ K. J., MONTADERT L., BERNOULLI D., BIZON G., CITA M. B., ERICKSON A., FABRICIUS F., GARRISON R. E., KIDD R. B., MÉIERES F., MÜLLER C. and WRIGHT R. C., 1978. Site 374, Messina Abyssal Plain., *in* : HSö K.J., MONTADERT L. *et al.* : Init. Rep. DSDP, XCLL, part 1, 175-217.

MöLLER J., HIEKE W. and FABRICIUS F., 1978. Turbidites at Site 374 : their composition, provenance and paleobathymetric significance. *in:* HSÜ, K.J., MONTADERT, L. *et al.* : Init. Rep. DSDP, XCLL, part 1, 397- 400.

MORPHOLOGICAL TYPES IN THE WESTERN PART OF THE MEDITERRANEAN RIDGE - DEFORMATION PATTERNS OF AN ACCRETIONARY COMPLEX

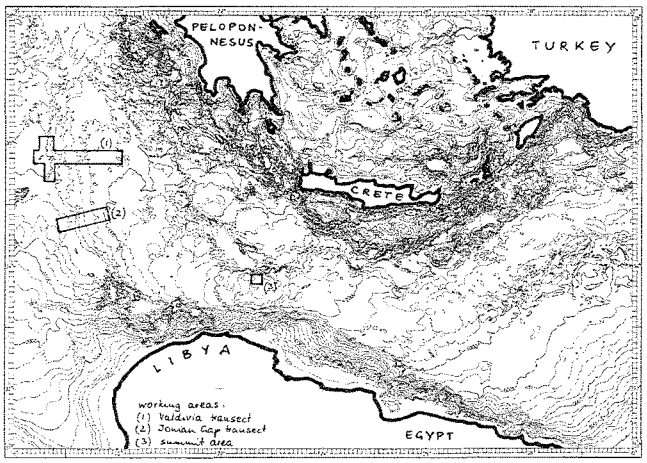
W. HIEKE[1], A. DEHGHANI[2], A. NEGRI[3], F. WERNER[4]

[1] Technische Universität München, Lehrstuhl für Geologie
85747 Garching. Germany
[2] Universität Hamburg, Institut für Geophysik, 20146 Hamburg, Germany
[3] Università di Bologna, Dipartimento di Scienze Geologiche, 40127 Bologna, Italy
[4] Universität Kiel, Geologisch-Paläntologisches Institut, 24118 Kiel, Germany

During Meteor cruise no. 25/4 (1993), the detailed morphology of the western part of the Mediterranean Ridge (MR) has been studied in two transects from western forelands onto the ridge and in the summit area SW of Crete (Fig.), and the deformation front bordering the Messina Abyssal Plain was surveyed.

The Hydrosweep swath-mapping system and a deep-tow side-scan sonar were applied during the profiling, together with continuous gravity and magnetic measurement covering the above areas. Four piston cores were raised from ponded deposits in order to study tectonical instabilities documented in the sedimentary sequences.

The bathymetric maps show impressing variations of the small-scaled relief. Side-scan sonar records allow the identification detail structures. The tectonic instability of the area is reflected in the sediment cores by slumping structures, debris flow and turbidite layers. The dating of these sequences should enable us to gain more insight into the tectonic history of the MR. The gravity and magnetic anomalies coincide with the prominent tectonic units. First gravity modelling for the summit area of MR indicates the possibility to identify mud diapirs.



MICROPALEONTOLOGY AND STRATIGRAPHY OF TWO CORES FROM THE ALBORAN SEA (WESTERN MEDITERRANEAN, "TRAINING THROUGH RESEARCH" CRUISE 1992)

Ekaterina M. IVANOVA, Anna A. LOTOTSKAYA

Geology Department, Moscow State Univ., Vorobjevy Gory, Moscow 119899, Russia

During the 1992 "Training Through Research" cruise of the R/V "Gelendzhik" in the Alboran sea, six gravity cores were taken. The longest cores, 73 and 74, located in the deepest part of the investigated area, were selected for micropaleontological/ stratigraphical study.

Core 73 is located on the slope of an underwater rise next to the southwestern edge of the Maimonid Ridge while core 74 is located on the gently tilted abyssal plain. The distance between the two core locations is 5 km. The cores were described and subsampled on board. They consist of light-brown bioturbated calcareous-clay muds in their uppermost parts (59 cm from the top in core 73 and 60 cm from the top in core 74). This unit is underlain by clayey-carbonate beige-grey muds with massive or indistinctly-laminated structures disturbed by bioturbation. This unit continuous to the depth of 87 cm in core 73 and to the depth 117 cm in core 74. Grey and green-grey layered muds with a silty lenses build up the lower parts of the cores. The interval contains turbidite sequence which is in particular distinct at the level of 243-370 cm from the top of the core 73 and 264-485 cm from the top of the core 74.

Core 73 was sampled every 10 cm and core 74 every 20 cm. Samples were weighted, washed over a >63 mm sieve, dried and split. In the fraction >100 mm at least 200 specimens of planktonic foraminifera were identified at a generic level. After counting, the residue was checked for rare species. In total 60 samples were studied, 18 species of planktonic and 22 genus of benthic foraminifera were identified.

Of special interest are distribution patterns of the main species *Gl. inflata* and *N. pachyderma*. It was shown by VERGNAUD GRAZZINI and PIERRE (1991) and TROELSTRA *et al.* (manuscript) that the replacement of *N. pachyderma* dominance by *Gl. inflata* dominance is an evidence of pycnocline deepening and reestablishing of active water ventilation in the Mediterranean dated about 7 ka BP. It also provides the evidence of water temperature increase because *N. pachyderma* which is known as a "cold"-water species is replaced by *Gl. inflata,* a member of temperature transitional assemblage. This event supports the hypothesis of a reversal of the hydrographycal regime in the Mediterranean.

A strong decrease in the intermediate and deep water ventilation was also noted in the Alboran basin between 8-9 ka BP, in phase with the last stagnant event in the eastern Mediterranean. This situation changed around 7 ka BP by reestablishment of the deep-pycnocline level and active ventilation of deep and intermediate waters. This level can be seen in the cores at a depth of 70 cm (core 73) and of 90 cm (core 74). Increasing numbers of *G. bulloides* at the same level in both cores support the idea of water regime changes. This species is always abundant in modern upwelling areas.

The appearance of *Gssacculifer* and the increasing numbers of *Gsruber* (representatives of warm subtropical fauna) at 100 cm in core 73 and 130 cm in core 74 support the idea of a warming trend from the Younger Dryas (11-10 ka BP) to the present climatic conditions.

The cool water species *T. quinqueloba,* present in a frequencies of 40-50% in the lower part of the cores, decreases dramatically in abundance from 100 cm upwards in core 73 and from 150 cm upcore 74. This species seems to be especially abundant at the time of cool and unstable water conditions during the Late Glacial time and Younger Dryas. Based on the above and also by extrapolation of the sedimentation rates the Holocene/Pleistocene boundary is placed at 100 cm in the core 73 and 140 cm in core 74.

The main feature of the foraminiferal assemblages from 100 and 140 cm downward in the cores is a strong dominance of cool water species such as : *N. pachyderma, T. quinqueloba* and *Gl. scitula*. Relatively high percentages of *Gl. inflata, N. dutertrei* and *G. bulloides* in the lower partof the core 73 suggest that the sediments at this level were accumulated during oxygen isotope stage 3.

Calculated sedimentation rates for the cores are about 10 cm/1000 years for core 73 and 13-14 cm/1000 years for the core 74 at least for Holocene. It coincides with interpretation by calcareous nannofossil data.

SEDIMENTATION IN A DISEQUILIBRIUM RIVER-DOMINATED ESTUARY. THE RASA RIVER KARSTIC ESTUARY (CROATIA)

Mladen JURACIC[1], Ivan SONDI[2], and Velimir PRAVDIC[2]

[1]Department of Geology, Faculty of Science, University of Zagreb, Zvonimirova 8
[2]Center for Marine Research, Ruler Boskovic Institute, Bijenicka 54
41000 Zagreb, Croatia

The paper describes sedimentation of terrigenous suspended matter in a small, rock-bounded, low-tidal estuary in the Croatian karst region : the Rasa River mouth in the northeastern Adriatic. It can be regarded as a model example of a disequilibrium river- (or input-) dominated estuaries (FAIRBRIDGE, 1980; KING, 1980).

Most of the incoming particulate material (more than 90 percent) is brought into the estuary as suspended matter, rather than as bed load. Suspended matter originates from the intensive weathering of Eocene flysch marls in the upper part of the drainage area (only 106 km^2 out of total 205 km^2) and, occasionally, from strong karst springs having catchment areas beyond the Rasa River topographic drainage area. The estuary is characterized by rapid sedimentation of fine grained, mostly clay mineral particles (BOLDRIN *et al.*, 1992; JURACIC, 1992). The rapid sedimentation in this salt-wedge estuary is enhanced by flocculation of fine-grained particles. A progradation of the estuarine (or bay-head) delta shown in Fig. 1.

A quantification of sediment accumulation in the prodelta zone (3 km long) indicates a mean load of approximately 80.000 t/y during the last thirty years (SONDI *et al.*, 1994). Classification schemes of transitional fluvio-marine environments, including estuaries (DALRYMPLE *et. al.*, 1992), and the conceptual classification of estuarine morphologies (COOPER, 1993) are considered.

On the basis of the results of investigations in the Rasa River estuary, it is proposed as a new typical model for disequilibrium river-dominated estuaries.

Indeed on the basis of its characteristics, it should be the foremost example of fluvial (input) dominated estuaries in the classification scheme in the ternary diagram involving wave, tidal and fluvial processes.

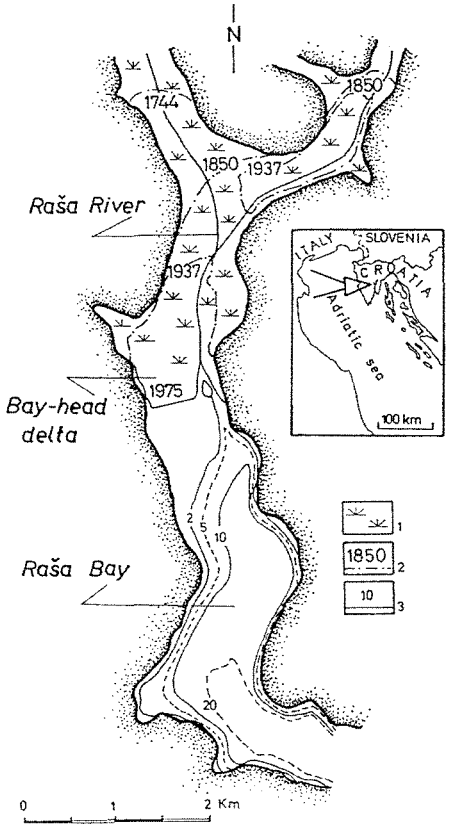


Fig.1. The Rasa River mouth. The time dependent filling of the rock bounded estuary is shown with indication of estuarine delta progradation: 1. alluvial sediments 2. historic progradation indicated by shore positions in respective years (after BENAC *et al.*, 1991); 3. recent isobaths in meters.

REFERENCES

BENAC C., ARBANAS Z. & PAVLOVEC E., 1991. Origin and geotechnical characteristics of the Rasa valley and bay. (in Croatian), *Pomorski zbornik*, 29 : 475-429.

BOLDRIN A., JURACIC M., MENEGAZZO-VITTURI L., RABITTI S. & RAMPAZZO G. (1992): Sedimentation of riverborne material into a shallow shelf sea. Adige River -Adriatic Sea. *Marine Geology*, 103 : 473-485.

COOPER J.A.G., 1993. Sedimentation in a river dominated estuary. *Sedimentology*, 40 : 979-1017.

DALRYMPLE R. W., ZAITLIN B. A. & BOYD R., 1992. Estuarine facies models: conceptual basis and stratigraphic implications. *Journal of Sedimentary Petrology*, 62 : 1130-1146.

FAIRBRIDGE R. W., 1980. The estuary: its definition and geodynamic cycle. *In* : Olausson E & Cato I. (eds.) Chemistry and Boiogeochemistry of Estuaries, Wiley, New York, p. 1-35.

JURACIC M., 1992. Sedimentation in some adriatic karstic river mouths. (Are they estuaries or rias ?). Proceedings of the International conference Geomorphology and the Sea, Mali Losinj, 1992. Department of Geography, Faculty of Science, 55-63.

KING C. J. H., 1980.A small cliff-bounded estuarine environment : Sandyhaven Pill in South Wales. *Sedimentology*, 27 : 93-105.

SONDI I., JURACIC M., RUBINIC J. & PRAVDIC V., 1994. Sedimentation in a disequilibrium river-dominated estuary. The Rasa River estuary/Adriatic Sea (Croatia). *Sedimentology*, (submitted).

THE DEPOSITIONAL ENVIRONMENTOF THE EVAPORITE MINERAL SERIES AT TUZLA, BOSNIA-HERCEGOVINA

G. KNIEWALD[1,2], V. BERMANEC[3] and D. TIBLJAS[3]

[1] Center for Marine Research Zagreb, Rudjer Boskovic Inst., 41000 Zagreb, Croatia
[2] Inst. of Applied Physical Chemistry, Research Center Juelich, 52425 Juelich, Germany
[3] Department of Mineralogy and Petrology, Faculty of Sciences, University of Zagreb, 41000 Zagreb, Croatia

Evaporites may occur in a variety of environmental settings ranging from coastal intertidal and supratidal zones (sebkhas), small coastal or atoll lagoons, deeper marine basins, sub-sealevel basins with marine inflow and non-marine interior basins. The tectonic and palaeogeographic circumstances span continental margins and shelves, interior cratonic basins and rifted continental margins. It is also highly interesting to note that evaporites having the mineralogy of non-marine facies sequences are rather rare in rocks older than Tertiary age.

The Tuzla salt deposit is located in the north-eastern part of Bosnia and Hercegovina and is the largest rock salt reservoir on the Balkan peninsula. The essentially stratified salt-dome type deposit is of middle Miocene age, hosted in a sedimentary series of banded halite and anhydrite. In spite of the rather well known geological setting of the occurence, there is no unambiguous evidence as to the depositional environment in which the evaporites formed. The geochemistry of coexisting brines and their saturation states imply that the formation environment may be interpreted in terms of the mixing-zone model, as opposed to the end-member marine or salt-lake type deposits (BERMANEC *et al.*, 1992). However, the close relationship of the evaporite series and associated dolomitic limestones, and evidence of progressive dolomitization may account for their formation under evaporative, non-evaporative or seepage reflux conditions (HARDIE and EUGSTER, 1971).

The mineral paragenesis of the evaporite series consists of halite, thenardite and anhydrite. The $a(H_2O)$ indicator couple is thenardite-mirabilite. In addition, several accessory minerals are present in varying amounts - the assemblage, as well as possible lithotype indicator minerals are being studied in detail (KNIEWALD *et al.*, 1986; BERMANEC *et al.*, 1992). Moreover, a new mineral with a pentaborate sheet structure has been discovered in the assemblage and was named tuzlaite (BERMANEC *et al.*, 1994). Its formation and stability are as yet unclear, but there are indications that diagenetic changes could have effectuated the nucleation kinetics of the normal succession of borate minerals in the sequence, resulting in the precipitation of tuzlaite.

The textures of the Tuzla anhydrite sequence provide no direct evidence that anhydrite might have grown directly from the brine. Gypsum is largely absent from the main evaporitic series, although some is associated with laterally correlated breccias indicating that the anhydrite-gypsum ratio was equilibrated over a series of metastable phases. Probable burial of an initially formed gypsum series and a consequent temperature rise due to the geothermaol gradient inevitably causes the transition to anhydrite. There is no evidence of ensuing rehydration, except - perhaps - in the case of the breccias described above. These characteristics can hint at the conclusion that uniformly lamellar anhydrite (or sulphate-carbonate sequence) formed in a protected "low energy" environment, usually to be understood in terms of a deep water basin, below the wave base. On the other hand, sharp brine stratification in an evaporite basin can attenuate wave motion at depths less than those expected for a uniform water column. The other type of intermediate anhydrite features irregularities characteristic of clastic sedimentation, such as ripples and cross bedding. In the case of anhydrite textural evidence is still ambiguous or conflicting.

Further studies, particularly involving the isotopes of sulphur and oxygen in the evaporites and limestones, should provide the rationale for a tenable assessment of the depositional setting of the Tuzla evaporite series.

ACKNOWLEDGEMENTS.

Part of this research was facilitated through a research fellowship awarded to GK by the Alexander von Humboldt Foundation of Bonn, Germany. Additional support was administered by the International Bureau of the Research Center (KFA) Juelich within the framework of the joint project Environmental Research in Aquatic Systems.

REFERENCES

BERMANEC, V., ARMBRUSTER, T., TIBLJAS, D., STURMAN, D. and KNIEWALD, G., 1994. Tuzlaite, $NaCa(B_5O_8/OH/_2).3H_2O$, a new mineral with a pentaborate sheet structure from the Tuzla salt mine, Bosnia and Hercegovina. *American Mineralogist*, 79 : 562-569

BERMANEC V., TIBLJAS D., CRNJAKOVIC M. and KNIEWALD G., 1992. Saline minerals of the Tuzla deposit as indicators of palaeooceanographic conditions. *Rapp. Comm. int. Mer Médit.*, 33 : 116

HARDIE L. A. and EUGSTER H.P., 1971. The depositional environment of marine evaporites: a case for shallow, clastic accumulation. *Sedimentology*, 16 : 187-220.

KNIEWALD G., BERMANEC V. and TIBLJAS D., 1986. On the origin and type of the Tuzla salt deposit in Yugoslavia. A trace element study of northupite and halite. *Rapp. Comm. int. Mer Médit.*, 30/2 : 72.

MUD VOLCANOES ON THE MEDITERRANEAN RIDGE : DISTRIBUTION AND POSSIBLE MECHANISM OF FORMATION

A. F. LIMONOV[1], M. K. IVANOV[1], M. B. CITA[2], E. ERBA[2], J. M. WOODSIDE[3] R. B. KIDD[4] and R. LUCCHI[4]

[1]UNESCO Research and Training Center on Marine Geology and Geophysics Geological Faculty, Moscow State University, Russia

[2] Dipartamento di Scienze della Terra, Universitá degli studi di Milano, Italy

[3] Faculteit der Aardwetenschappen, Vrije Universiteit, Amsterdam, the Netherlands

[4] Department of Geology, University of Wales, Cardiff, U.K

About twenty new mud volcanoes and mud diapirs on the Mediterranean Ridge south of Crete were discovered during the TTR-3 Cruise of the R/V Gelendzhik (June-July 1993) with the aid of swath survey with two types of sidescan sonars. Nine of them were checked by bottom sampling and the mud breccia were found occurring at shallow depth (a few centimetres to a few metres) below the seafloor. The comparison of the coordinates of the newly-discovered mud volcanoes and the highly reflective patches in the GLORIA mosaic (KENYON *et al.*, 1982) shows that most of these patches (with the possible exception in the Hellenic Trench area) represent not the dissolution structures related to the Messinian evaporites but mud volcanoes and mud diapirs.

These structures are widespread on the Mediterranean Ridge, especially south and west of Crete and they concentrate mainly in the crestal and inner parts of the Ridge, decreasing in size towards the Ridge flanks. The structures are mostly elongated and are aligned according to the general trend of the Ridge. Many of them are related to the principal thrust(?) planes.

The mud volcanism and diapirism phenomenon is closely tied to the Mediterranean Ridge accretionary complex evolution. A strong lateral compression results in stacking of sedimentary slabs with different lithologies and densities, contacting along thrust planes. Less dense plastic rocks saturated with gas and fluid could be overlain by denser rocks. This would create the density inversion and overpressuring in the plastic units, giving rise to the diapiric growth or the breakthrough of the deep-seated material to the seafloor along fault and thrust planes. At the same time, tectonic compressional stress across the Ridge can squeeze plastic material upward to the seafloor. The role of the Messinian evaporites in this process seems to be insignificant. They hardly can form an impermeable layer enhancing the overpressuring effect in the underlying rocks. Recently obtained seismic data (HIRSCHLEBER *et al.*, 1994) confirmed by the data of the TTR-3 Cruise suggest that the Messinian is missing at many places on the Mediterranean Ridge crest. Moreover, we suppose that the mud volcanoes and diapirs are located just at the places where the Messinian is missing, otherwise the greatest manifestation of the mud volcanism should be expected on the southern Ridge flank covered by relatively thick Messinian layer.

REFERENCES

HIRSCHLEBER H. B., HARTMANN J. M. and HIEKE W., 1994. The Mediterranean Ridge accretionary complex and its forelands - seismic reflection studies in the Ionian Sea. Universität Hamburg 1994 - Schlaglichter der Forschung zum 75. Jahrestag, ed. by R. Ansorge. Hamburger Beiträge zur Wissenschaftsgeschichchte, Reimer Verlag, Berlin, 15 : 491-509.

KENYON N. H., BELDERSON R. H. and STRIDE A. H., 1982. Detailed tectonic trends on the central part of the Hellenic Outer Ridge and in the Hellenic Trench system. Trench-Forearc Geology, Geol. Soc. Spec. Publ., ed. by J. Leggat, 10 : 335-343.

COBBLESTONE AREA ON THE WESTERN MEDITERRANEAN RIDGE : RE-VISITED AGAIN. A PRELIMINARY REPORT

A .F. LIMONOV, M. K. IVANOV and G. G. AKHAMANOV

UNESCO Research and Training Centre on Marine Geology and Geophysics, Geological Faculty, Moscow State University, Russia

During the 4th Training-through-Research Cruise (1994), the underway 2-day investigations in the Cobblestone area on the western Mediterranean ridge were carried out with the OKEAN long-range sidescan sonar and the MAK-1 deep-tow acoustic system. This area was chosen by two reasons :

(i) the Prometheus mud diapir in this locality was the first one discovered on the Mediterranean Ridge, and its mud breccia contains the fragments of the oldest (Middle Cretaceous) rocks (CITA *et al.*, 1981; RYAN *et al.*, 1982);

(ii) on the Gloria mosaic, compiled by KENYON *et al.* (1982), some highly reflective patches arranged along a single lineament are seen in the Cobblestone area. The position of one ot them coincides with the known position of the Prometheus mud diapir, that is why other dark patches were supposed to be mud diapirs and mud volcanoes as well.

Two parallel tracks ran with the OKEAN sidescan sonar roughly in a N-S direction allowed us to make the mosaic for the area with a total swath range of about 25 km. Some features with intensive backscatter on that mosaic turned to be wide outcrops Hellenic Trench system. However, at least four dark patches looked very similar to mud volcano images obtained in the Olimpi mud diapir field in 1993 (LIMONOV *et al.*, 1994). On the basis of that mosaic, a MAK-1 line was run between the two OKEAN lines and continued further North, beyond the area covered by the OKEAN swath. The length of the line is about 40 km with the swath range of 2 km. Along this line, six circular structures have been recorded. All of them have a diameter of 2-2.2 km and a relative height of up to 130 m. These structures are closely spaced and sometimes have common borders. Three of them are typical mud volcanoes with craters 100-200 m in diameter and extensive mud flows on their slopes. The cores from them gave the mud breccia below a few tens of centimetres of oxidized Holocene sediments. The clasts from the mud breccia are very variable in composition, and, according to the preliminary shipboard microfossil definitions, may have the age from Cretaceous to Pliocene. The rest of the circular structures are probably inactive extinct mud volcaneos. They have well-defined rims and are covered by an approximately 30-m layer of acoustically stratified sediments pinching out toward the rim. The margin of one of them is protruded by a narrow cone-like feature which could be a clay diapir. The new discovered mud volcanoes are undoubtedly related to a system of thrust plains parallel to the general trend of the Mediterranean Ridge and they may reflect several stages of tectonic activity of the ridge.

REFERENCES

CITA M. B., RYAN W. B. F. and PAGGI L., 1981. Prometheus mudbreccia: An exemple of shale diapirism in the Western Mediterranean Ridge. *Ann. Geol. Pays Hellen.*, 30 : 543-570.

KENYON N. H., BELDERSON R. H. and STRIDE A. H., 1982. Detailed tectonic trends on the central part of the Hellenic Outer Ridge and in the Hellenic Trench System. Trench-Forearc Geology, Geol. Soc. Spec. Publ., ed. by J. Leggat, 10 : 335-343.

LIMONOV A. F., WOODSIDE J. M. and IVANO, M. K. (eds.), 1994. Mud volcanism in the Mediterranean and Black seas and shallow structure of the Eratosthenes Seamount. UNESCO Reports in Marine Science, 64 : 173 pp.

RYAN W. B. F., KASTENS K. A. and CITA M. B., 1982. Geologic evidence concerning compressional tectonics in the Eastern Mediterranean. *Tectonophysics*, 86 : 213-242.

A NEW HALOGENETIC MODEL FOR THE MIOCENE "SALINITY CRISES" OF THE EASTERN CENTRAL PARATETHYS AND MEDITERRANEAN BASINS

Jerzy LISZKOWSKI

Institute of Geology, A.Mickiewicz's University, Makow Polnych Str.16, 61-606 Poznan, Poland

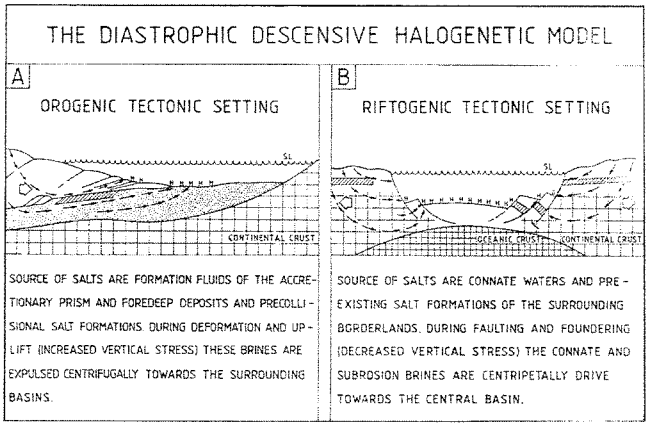
Thick Miocene salt formations are known from two areas of Europe mainly : from the eastern Central Paratethys Basins of the Carpathian region and the West and East Mediterranean Basins of the relict Neotethys. The first are of Lower to early Middle Miocene (Late Egerian- Eggenburgian, Karpatian and Middle Badenian) age, the second - of Upper Miocene (Messinian) age. The first occur in foredeep and back arc structural basins of the Carpathian thrust belt and are syn-collisional deposits, the second occur in deeply foundered extensional basins between the circum-Mediterranean Alpine thrust-belt chain and are mainly early post-collisional deposits. For both an evaporitic origin was and is up to now postulated, i.e. it is assumed that their deposition was climatically controlled. For the first a marine shallow water shallow basin to sebkha depositional model is mainly accepted, for the second, a dessicated marine shallow water deep basin depositional model proposed by HSU *et al.* (1973) is still accepted . In both cases the accepted evaporative genetic model and the proposed depositional models needs revision.

For the time of Lower and Middle Miocene salt deposition within the eastern Central Paratethys Basins of the Carpathian region paleobotanic, both macro- and micro- floral, and paleozoological data suggest a warm and humid, sometimes even wet Cfa, occasionally Cw *(sensu* Koppenen) climate, with precipitations exceeding evaporation; this excludes the possibility of extensive evaporitic salt deposition (LISZKOWSKI, 1989). The author also documented that the geologic setting, facies associations and internal fabric of the salt formations point for deep water depositional environment and that their lithofacies distribution, mineralogy and geochemical composition are in many respect quite unusual and do not fill the rules of the evaporitive genetic model. A new orogenic descensive halogenetic model was proposed for the salt formations discussed (LISZKOWSKI, 1989).

For the time of Upper Miocene (Messinian) salt deposition within the West and East Mediterranean Basins only in latest time GREGOR (1990) documented on the basis of both intensive and extensive analyses of macrofloral assemblages from many Miocene localities all around the European hinterland that : (1) no changes in floral composition in pre-, syn-, and post-Messiniam times occured, (2) there are no signs of arid or dry phases in the floras, meaning lack of "steppic", savanna - type or Mediterranean - type elements, and (3) the climate in Messinian time was wet, probably a certain Cw-climate (dry winter, wet summer), markedly different from the Recent Cs-climate of the Mediterranean area. He concluded, that the Messinian Salinity Crisis need another explanation.

The following genetic model for the Messinian salt formation of the Mediterranean Basins is proposed : as the result of the strong and rapid, collapse-like subsidence (foundering) of the basins and the rising thrust-belts surrounding them, a strong topographic and pressure gradient developed directed towards them. They acted as large-scale wells or sinks for groundwater flow. The drained groundwaters were very probably highly mineralized saline formation waters and brines with salinities up to 350 kg m^{-3} and more and mostly of the Cl-Na hydrogeochemical type. These dense and warm subsurface brines accumulate at the bottom of he basins. Precipitation of halite starts as the result of cooling and progressively continued in time. The salt precipitated start as deep-water deposits and only at the final stages the depositional environment probably changed into an shallow water one. No dessication of the Mediterranean basins occured. Simple mass bilance calculations for a wide range of realistic values of drawdown, hydraulic gradients, rock permabilities and groundwater salinities confirm the proposed model.

The proposed genetic model of Messinian salt deposition within the Mediterranean Basins as well as the postulated orogenic descensive halogenetic model for the Miocene salt formations of the Carpathian Paratethys Basins stress the active role of the tectonic and somewhat drop the importance of the climatic factor for giant salt deposition. Both models are end members of a more general diastrophic descensive halogenetic model (Figure). But they do not imply that the classic evaporative model is incorrect !



REFERENCES

GREGOR H. J., 1990. Contributions to the Late Neogene and Early Quaternary Floral History of the Mediterranean. *Palaeobotany and Palynology Review*, 62 : 309-338.

HSU K. J., CITA M. B. and RYAN W. B. F., 1973. The origin of the Mediterranean evaporities. *In*: Ryan W. B. F., Hsu, K. J. *et al.*, Initial Reports of the Dead sea Drilling Project., v.13, Washington, US Gov. Printing Office, p.1203-1231.

LISZKOWSKI J., 1989. A new halogenetic model for the origin of Lower and early MiddleMiocene salt formations of the Carpathian region eastern Central Paratethys. *(In* Polish, with Engl. and Russ. res.) Prace Naukowe Uniw. Slaskiego w Katowicach n°1019, Katowice 102 p.

DETAILED MICROPALEONTOLOGICAL STUDY OF THE DEEP-SEA CORE TTR3-80G FROM THE OLIMPI MUD-DIAPIRIC AREA (EASTERN MEDITERRANEAN)

Anna A. LOTOTSKAYA, Ekaterina M. IVANOVA

Paleontology Department, Moscow State University, Vorobjevy Gory, Moscow 119899, Russia

A dynamics of changes in the foraminifera and nannoplankton assemblages during the Quaternary are in common use as a key for an interpretation of climatic fluctuations and biostratigraphy of the Mediterranean region.

Detailed calcareous nannofossil and planktonic foraminifera quantitative analyses were carried out on 51 samples from the deep-sea core TTR3-80G. The core was raised from the Mediterranean Ridge plateau (to the south of Crete) at 33°39.00'N, 24°34.72'E, at a water depth 1877 m. This hemipelagic core includes "marker-bed" (manganese-rich thin black layer, dated as 4 kyrs B.P.), tephra layer Y-5 (40 kyrs B.P.) and 3 sapropels identified by their assemblages of planktonic foraminifera and calcareous nanofossils as S-1, S-5 and S-6.

The stratigraphic time framework is provided by correlation of isochronous lithologies and nannofossil biostratigraphy. The core sediments are represented by two biozones: *Emiliania huxleyi* and *E. huxleyi Acme*. The beginning of the *E. huxleyi Acme* Zone is calibrated with isotope/faunal stage 4 (53-54 kyrs B.P.).

Planktonic foraminifera were studied in a fraction greater than 125 m. For a quantitative analysis the samples were split to appropriate size, and about 300 specimens were identified and counted in each of the samples. In total 26 species of planktonic foraminifera were identified. Two main groups can be determined for the studied area on the basis of their ecology; "cool-water" assemblage includes such species as : *N. pachyderma, T. quinqueloba, G. bulloides*; "warm-water" assemblage : *Gs. ruber, Gs.acculifer, Gs. tennelus, G. rubescens, Gl. aequelateralis. N. dutertrei* was used as an index of surface water refreshing (law salinity index).

Changes in abundance of different calcareous nannoplankton species or pairs of species gives the opportunity to reconstruct the fluctuations between glacial and interglacial conditions over the last 200 kyrs : Riss glaciation (approximately 200-127 kyrs B.P.), Termination II (127-104 kyrs B.P.) and Wurm glaciation (approximately 104-10 kyrs B.P.). A short return to the warm conditions during the Riss glaciation is about 164-150 kyrs B.P., and during the Wurm glaciation - around 40 kyrs B.P. These boundaries are estimated using the rates of sedimentation (2.2-2.5 cm/kyr during the Pleistocene).

All recovered sapropels reveal peculiar assemblages of planktonic foraminifera and calcareous nannofossils. Sapropels S-1 and S-5 are represented by "warm-water" fauna and flora. On the contrary, sapropel S-6 contains "cool-water" assemblage, for planktonic foraminifera consisting of only 5 species. The productivity of foraminifera in that interval is about 10 times higher than in the rest of the core. It is also possible to determine warm - and cool - water intervals inside the sapropels.

The core reveals a great abundance of redeposited miocene-pliocene calcareous nannofossils probably originated from Moscow mud volcano. The absence of this material in sapropel layers shows that sapropels were deposited under the stagnant anoxic conditions.

G

THE BOUGUER GRAVITY FIELD OF THE MEDITERRANEAN SEA : CRUSTAL DEFORMATION AND ISOSTACY

J. MAKRIS and C. HENKE
Institut für Geophysik, Universität Hamburg, Germany

A new Bouguer Gravity map of the Mediterranean sea and adjacent countries originally prepared as an overlay sheet for the International Bathymetric Chart of the Mediterranean sea has been reprocessed and evaluated. In general, the gravity anomalies and their broad distribution reflect the topographic features; for example, the deep Ionian Basin and the Sardino-Balearic Abyssal Plain are floored by broad positive gravity features in the order of 180 to 200 mgals. The Herodotus Abyssal Plain in the eastern Mediterranean has a gravity maximum of 160 to 170 mgals extending from the Egyptian Coast to the Eratosthenus seamount. Most surrounding continental areas including western Turkey, western Greece, the Calabrian Apennine Arc, parts of North Africa and the western Mediterranean countries are all marked by negative Bouguer gravity features from zero to -180 mgals. We combined deep seismic soundings with associated gravity anomalies and, by computing 2-D density models, we were able to show that most of the deep basins of the Mediterranean sea are floored by old oceanic crust covered by sediments of variable thicknesses exceeding 10 km in parts. The surrounding continental margins of the North Mediterranean basins are all floored by continental crust that varies in thickness between 25 and 40 km depending on the state of deformation that geological processes have imposed on them by compression. Isostacy is mainly distributed along still active compressional fronts which expose strong seismic activity and systematic deepening of the Benyoff Zones from the onshore to the offshore areas. A series of crustal models and the development of the various basins will be presented and discussed.

SEISMICITY AND DEFORMATION OF THE LIGURIAN SEA

J. MAKRIS[1], K. LANGE[1], J. DEVERCHÈRE[2], C. EVA[3], N. BETHOUX[4]
[1] Institut für Geophysik, Universität Hamburg, Germany
[2] Laboratoire de Géodynamique sous-marine, Université Pierre et Marie Curie, Villefranche sur Mer, France
[3] IGG, Departemento de Scienze della Terra, Genova, Italy
[4] Institut de Géodynamique C.N.R.S., Valbonne, France

In Autumn 1992, a co-operative seismic programme between German, French and Italian geophysicists was performed in the Ligurian sea and adjacent coastal areas in order to study the seismic activity and tectonic deformation of these geologically complex regions. Forty-four mobile seismic stations onshore and twelve OBS (ocean bottom seismographs) offshore were deployed and the seismic activity was observed for 100 days onshore and 30 days offshore. The evaluation of the data identified 110 events of magnitude greater than 0,9. The obtained accuracy of the epicentral locations is better than 5 km and will be improved after the correct crustal model for this area has been considered. The model is being evaluated from deep seismic soundings offshore Côte d'Azur where the limit between the continental and oceanic crusts was identified. The seismic foci delineated active tectonic lineations and showed that the Sestri Voltagio Zone is particularly active undergoing intense deformation. The trends of the offshore events are still being studied but seem to be associated with salt tectonics and transform faults. The main seismicity offshore was located at depths of 7 to 13 km while onshore, deeper events to a depth of 25 km associated with crustal shortening across the Maritime Alpes were recorded. The evaluation of focal mechanisms is expected to identify the sense of movement between the various blocks of the eastern Ligurian sea.

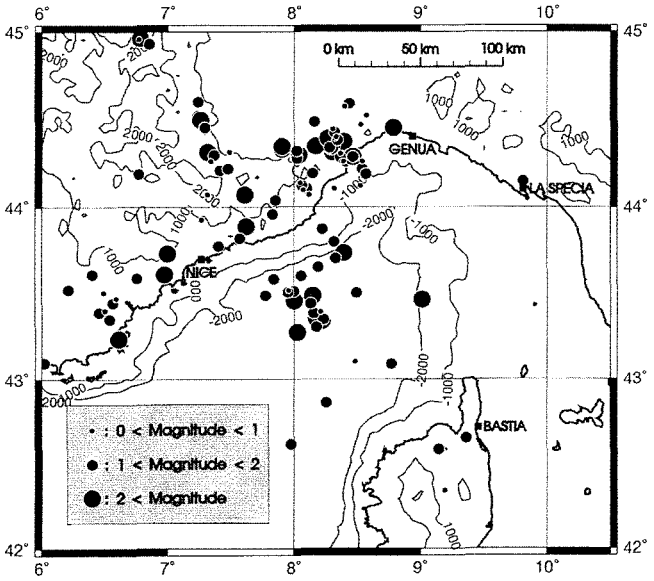


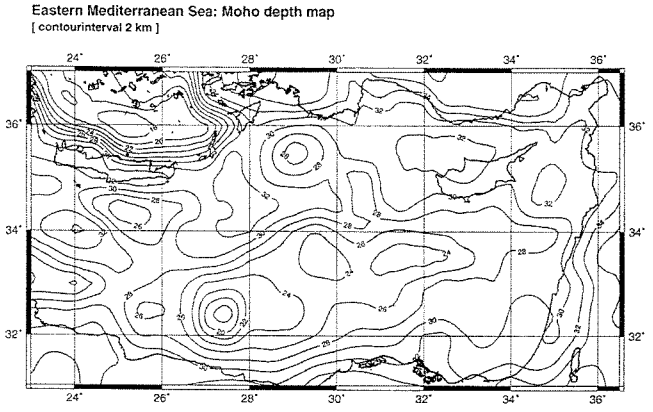
Fig. 1 - Topographic map with locations of earthquakes. Contours are in metres.

CRUSTAL EVOLUTION OF THE EASTERN MEDITERRANEAN SEA, DEDUCED FROM GEOPHYSICAL DATA

J. MAKRIS, J. WANG, J. LIU

Institut für Geophysik, Universität Hamburg, Germany

By combining gravity, magnetic and deep seismic sounding data, a new crustal thickness map of the eastern Mediterranean sea has been computed. The crustal thickness varies from 18 km below the Herodotus Abyssal Plain to a maximum thickness below the Cyprian arc where it is 30 to 32 km thick. The arc is presently deforming by compression of the Cyprian continental lithosphere and the oceanic lithosphere lying below the Herodotus Abyssal Plain. 3-d modelling revealed that the isostatic balance is achieved only below deep basins and that isostacy is mainly disturbed at the compressional fronts and at the Eratosthenus seamount. All deep basins are floored by oceanic crust and are inversely magnetised. This indicates that they are of Jurassic age. Subsidence has been affecting the area during the last 5 million years resulting in thick sedimentary sequences exceeding 10 km in parts. The area between Crete and Egypt is also under strong compression resulting in crustal thickening. Oceanic lithosphere is being presently subducted below the Hellenic Arc, and the Mediterranean Ridge is developing due to compression. Apart from the Eratosthenes seamount which is a remnant of stretched continental crust 22 km thick, no continental fragments could be encountered outside the Cyprian arc. Seismicity is strongly associated with the compressional processes at the Hellenic and Cyprian arcs, and low heat flow density values which are recorded in the deeper parts of the basins can be explained by fast sedimentation rates that depress the isothermal distribution, and by an oceanic crust and lithosphere of low radioactive content.



A NEW GRAVITY MAP OF GREECE : DEDICATION TO DR. AGELLOS STAVROU

J. MAKRIS[1], T. FOKIANOU[2], J. SIDERIS[3]

[1] Institut für Geophysik, Universität Hamburg, Germany
[2] Public Petroleum Corporation of Greece S.A., Athens, Greece
[3] Institute of Geophysics and Marine Research, University of Athens, Greece

A new gravity map of Greece has been processed by re-evaluating nearly 26,000 stations onshore and from the results of a new gravity survey offshore. The average grid spacing covering the Aegean sea was 3 km while the Ionian sea was less well constrained at an average spacing of 8 to 10 km. The data have been reduced for topographical effects using a constant density of 2.67 g/cm^3 The resulting Bouguer Map shows strong negative anomalies along the western Hellenides with values ranging between -30 and -130 mgals. The Aegean area is floored by stretched continental crust and deforming mainly by extension. Maximum Bouguer values of 160 mgals occur in the Cretian sea and a series of anomalies ranging from zero to 100 mgals cover the central and northern parts of the Aegean sea. The Ionian area has strong Bouguer anomalies of nearly 200 mgals south-west of Cephalonia and Zakynthos, while offshore Corfu and Paxos Island, gravity ranges between 10 and 40 mgals. By separating the regional trends of the field from the observed, we plotted residual anomalies that clearly mark the deformational style of the sedimentary basins associated with the western Hellenides, and the deformational front associated with compression between the South Aegean arc and the Libian sea. Isostacy is strongly disturbed at the external compressional front of the Hellenides while the Aegean sea, controlled mainly by extension, is in isostatic balance. Crustal geometry and thickness determined by combining deep seismic soundings and gravity picture the tectonic regimes of the various provinces of Greece and their association with seismicity. Density distribution, isostacy, seismicity and tectonic deformation are strongly associated with each other.

G

CONTINENT - OCEAN COLLISION AND THE ACTIVE DEFORMATION OF THE WESTERN HELLENIDES

J. MAKRIS[1], T. FOKIANOU[2], E. KAMBERIS[2] F. EGLOFF[1], S. WANG[1]

[1] Institut für Geophysik, Universität Hamburg, Germany
[2] Public Petroleum Corporation of Greece S.A., Athens, Greece

An onshore-offshore seismic survey performed in 1994 across three transects, from the deep Ionian sea to the western Hellenides, revealed that the crust and lithosphere offshore western Greece is of oceanic origin. The sediments have a thickness of 8 to 10 km while the crust below them is only 5 to 6 km thick, and the lithosphere does not exceed 25 km thickness. The deformation below the Hellenides is very intense and compressional processes have uplifted limestones of high velocity and density above softer sediments and Mesozoic anhydrites. Thickness of the post-Miocene sedimentation is very unevenly distributed over the entire area and strongly depends on the intensity of the horizontal deformation. Compression has forced the sedimentary sequences to glide over each other causing horizontal shortening of 40 to 50 km in places. The compressional processes are not developing in a uniform manner along the compressional axis and show strong lateral variations. The Mesozoic sediments have been strongly deformed and hydrocarbons associated with the early development of the Mesozoic basins must have migrated to higher levels of the sedimentary sequence. This process is responsible for oil and gas accumulation at economic depths within the Ionian Zone, and should be expected particularly under flysch covered areas where the flysch is acting as a cap-rock to oil and gas traps.

COMPARATIVE GEOMORPHOLOGICAL OBSERVATIONS IN THE KALAMAS DELTA IN WESTERN GREECE AND THE SPERKHIOS DELTA IN EASTERN GREECE

H. MAROUKIAN, K. GAKI-PAPANASTASSIOU, K. PAVLOPOULOS and A. ZAMANI

Department of Geography-Climatology, University of Athens, Panepistimiopolis, 157 84 Zografou, Athens, Greece

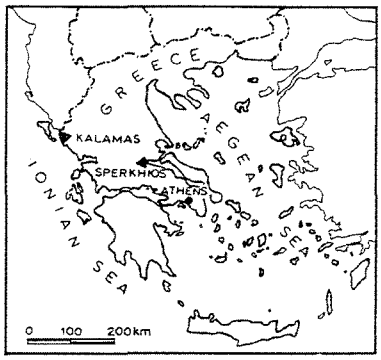


Fig.1. Location of the deltas of the Kalamas and Sperchios rivers in Greece.

The evolution of the deltas of Greece is depended on the areal extent, lithologic composition, slope, orientation, climatic conditions and vegetation cover of their drainage systems which evolve on a young and highly irregular relief owed to recent and intense tectonic activity of the Hellenic region. Their seasonal bedload variations are directly depended upon the unpredictable Mediterranean climate. The receiving basins and sea conditions are other important factors affecting delta growth. This study focuses on two significantly different deltaic environments of Greece, the Kalamas river which empties into the Ionian sea in the West and the Sperkhios river which empties into the semi-enclosed Maliakos gulf in the east (Fig.1). The Kalamas river has formed a cuspate type delta when it debouches from the Pindus mountain range (Fig.2). Its 1826 km^2 drainage basin has given rise to a 78 km^2 delta joining a number of former limestone islands to the mainland. The river has changed its course many times filling up the intermediate basins between the islands. Human interference in the form of a low dam at the apex of the delta and an artificial channel with a second mouth have been determinative in the evolution of the delta in recent decades. The sea has covered large parts of the inactive old delta thus destroying cultivated lands and irrigation works. The drainage basin (1780 km^2) of the Sperkhios river is located in an East-West trending, elongated, assymetric and active tectonic depression (Fig.3). The river flows East and empties into the relatively calm, shallow, less than 27 metres deep, Maliakos gulf. It has formed a digitate type delta having silted up an area of 104 km^2 during the last 2500 years. It is characterized by frequent channel changes, the last one having occured about a century ago in the area of Thermopylae. Until recently, the Sperkhios had not been affected by human interference. Today, a dam is being constructed on its major tributary, the Vistritsa.

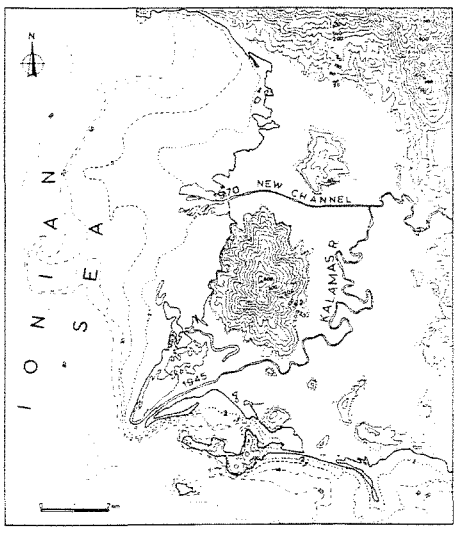


Fig.2 The delta of the river Kalamas.

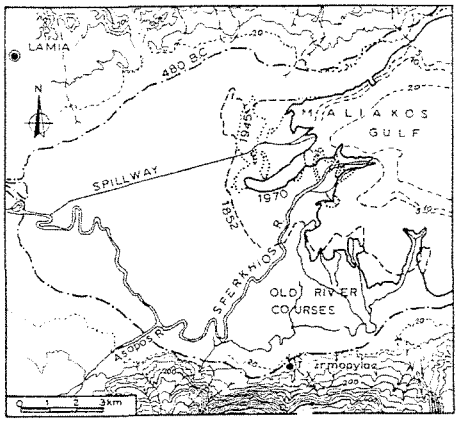


Fig.3 Deltaic growth of the Sperkhios river from 480 B.C. till 1970.

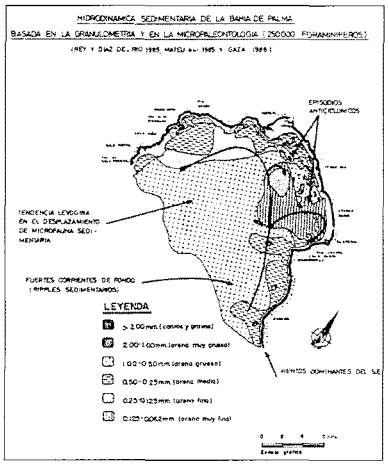
BAHIA DE PALMA DE MALLORCA (BALEARIC ISLANDS – SPAIN) : NEOGEN–QUATERNARY HYDRODYNAMICS AND MICROPALEONTOLOGY

MATEU G.

I.E.O., Centro Oceanográfico de Baleares, 07080 Palma de Mallorca, Spain

Bahia de Palma : Foraminifers, littoral drift and fossil beaches. The "Bahia de Palma" forms a geometric unity between the coastal south–western shelves of the third mesozoic series of the "Serra de Tramuntana" and the tortonomesinian formations of the marine of "Llucmajor" with its ancient reef character. Its sedimentology (JAUME & FORNÓS, 1992) offers some biofacies or biological features of the sediments that in the light of a qualitative and quantitative study upon the foraminifers are the following: forms of epiphitic origin (*Miliolidae, Cibicidae, Discorbidae,...*) and of sammic and terrigenous origin (*Glabratellidae, Textulariidae, Elphidiiae*) are present all over the "Bahia" in consonance with extensive meadows of vegetables, or production–sources, followed by tafocenotic dynamics regulated by the paleocourses, the distribution of sands and its granulometry, as well as other physical and geological factors in the area. Above all, the sinistral littoral drift shows a major specific diversity and a remarkable gathering of benthonic and planktonic forms in the northern part of the "Bahia" (T2). All that and the following allowed us the hydrodynamic model of the "Bahia de Palma" (MATEU, 1989), recently corroborated by the "numerical model" of WERNER *et al.* (1993). These species mainly live within 1 and 40 m of depth, in the inner shelf, within normal salinity and even hyper–salty lagoons. Its steady permanance upon algae and rocks, in temperate tropical areas is associated to *Miliolidae, Soritidae, Planorbulinidae, Vertebralina*, etc., and its philotropical character makes us relate it to the climatic requirements of *Soritidae*, which appears in the "Bahia" on the paleo–reefly miocenic coast of "Cap Blanc" (S14), wherein the ancient *Amphisteginidae* replaced by the present *Soritidae* would evoke the plio–pleistocenic continentalization of the Mediterranean and the resulting supplanting of the shallow reefly ecosystem by the photophylum communities of *Cimodocea* and *Caulerpa* of the infralittoral zone of the "Bahia de Palma" (MATEU, 1991). Its eutirrenien macrofauna is characterized by thermophile and senegalese species, with echinoderms, mollusca, etc. (*Strombus, Brachydontes, Patella*, etc.), feebly cemented and its microfauna of foraminifera, also thermophile, offers 69 species, belonging to 16 families, whose shells are mainly calcareous–porcellaneous (*Nubeculariidae 50%, Miliodae 25%*, etc.), which presupose meadows of *Posidonia* and coastal fringe of *Cymodocea, Caulerpa*, etc., as the microfaunistical morphotypes respond to this kind of vegetation (LANGER, 1993) (S40, S17).

Epineritic marsh : neogene quaternary evolution and microfauna. Local phases of quaternary subsidence in accordance with the puzzle of subsident blocks all along the pliocenic paleochannel of Mallorca, which joint the "Bahia de Palma" with the ones of "Pollença y Alcudia". The different bathymetric distribution of the lithologic unities (calcisiltits of Son Mir, calcarenits of Sant Jordi and silts of Palma) remain confirmed by the magnetic anomalies and the bihorizons of the first and last appearence of certain planktonic species (MATEU, 1985). That way, in corer S40, beside the airport, in the calcisiltits of the basal Pliocene, lacustral ostracods (*Cyprideis torosa*) appear within levels inferior to the planktonic bloom of mesoepipelagic species (*Orbulina universa, Globigerinoides trilobus, G. inmaturus, Sphaerodinella subdehicens, Globorotalia puncticulata, G. margaritae*, etc.) whose synchronus character requires a mesopliocene marine environment (THUNNEL, 1979), which has nothing to do with that inferior pliocene sedimentation of the deep Mediterranean basins, with stratigraphic hiatus (zonations MPL1 and MPL2), which suggest a very strong hydrodynamic of the deep waters (KIDD *et al.*, 1978). Meanwhile our plankton would be tied to peripheric outcrops or to eolic gatherings, which remind us of the present planktonic depositions of the "salinas de Fornells" (Menorca) (MATEU *et al.*, unedited). The microfaunistic element, benthonic and infra–circalittoral, mainly characterises the superopliocenic calcarenits in consonance with the biodetritic model of a rocky coast and a internal shelf covered with meadows of vegetables, coralline and maërl (BLANC–VERNET, 1969), and wherein certain euryhaline foraminifers (*A. beccarii, Florilus boueanus, Elphidium sp.*), and salty ostracods, as *Cyprideis torosa*, offer a progressive adaptation to the adjacent marshes, testified by the sequence of margine–coastal facies, tipical of the plio–pleisto–holocenic environment (VIÑALS *et al.*, 1989).



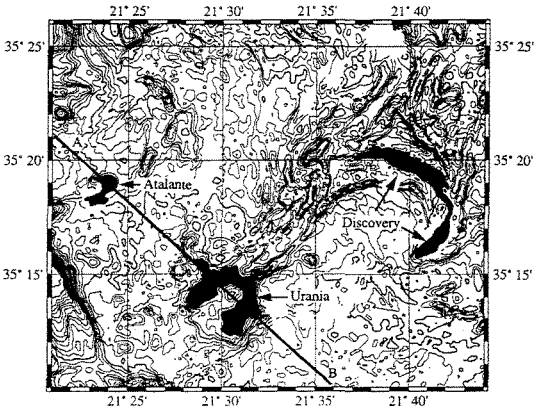
REFERENCES

BLANC–VERNET L., 1969. Extr.Rec.Trav. Stat. Mar d'Endoume 64 (68) : 1–279.
JAUME C. & FORNOS J., 1992. *Bol. Soc. Hist. Nat. Balears* 35 : 93–110.
KIDD R. B., CITA M. B. and RYAN W. B .F., 1978. Init. Rep. DSDP, XLII, pp. 421–443.
LANGER M. R., 1993. *Mar. Micropal.* 20 : 235–265.
MATEU G., 1985. Pleistoceno y Geomorfología Litoral, 196 págs.
MATEU G., 1989. *Rev. Ciencia* (IEB) 4 : 65–81.
MATEU G., 1991. Micropaleontología sedimentaria del Caribe 125 págs.
THUNELL R. C., 1979. *Micropal.* 25(4) : 412–437.
WERNER F. E., VIUDEZ A. and TINTORE J., 1993. *Journ.Mar.Syst.* 4 : 45–66.
VIÑALS M. J., MATEU G. FUMANAL M. P., USERA J. and FAVERO V., 1989. *Cuaternario y Geomorfología*, 3(1–2) : 93–104.

NEWLY DISCOVERED BRINE LAKES IN THE SEABED OF THE MEDITERRANEAN RIDGE, SOUTHWEST OF CRETE

MEDRIFF Consortium : G. K. Westbrook[1], R. F. Woollett[1] X. Le Pichon[2], S. Lallemant[2], N. Chamot-Rooke[2], J.-P. Foucher[3], F. Harmegnies[3], E. Suess[4], A. Bleyer[4], M. B. Cita[5], N. Fusi[5], G. Aloisi[5], A. Camerlenghi[6], A. Polonia[6], B. Della Vedova[7], G. Pellis[7], L. Mirabile[8], V. Severino[8], P. Pavlakis[9], M. Alexandri[9]

Ten years after the discovery of the Tyro basin, two more deep sea brine lakes were discovered in the eastern Mediterranean sea in September 1993, during cruise 93/19 of R/V Urania as part of the MAST-II programme MEDRIFF (An Integrated Investigation of the Fluid Flow Regime of the Mediterranean Ridge). The brine lakes were shown on acoustic and sparker profiles run across basins mapped by a multibeam bathymetric survey conducted by the N.O. L'Atalante the year before. A third brine lake was identified during a cruise of RRS Discovery which investigated the area in December 1993 and January 1994. The three basins have been named after the three oceanographic vessels. The Urania, L'Atalante and the Discovery brine lakes are located at the south-western edge of the Inner Plateau, a relatively flat and depressed area considered to act as the backstop to the Mediterranean Ridge accretionary complex, lying between the Ridge and the Matapan Trench. The Inner Plateau is separated from the Inner Deformation Front of the Mediterranean Ridge by a deep trough in which brines do not accumulate. The shape of the Urania Basin in plan view is of a horse shoe with a width of about 6 km, very similar to that of the Bannock Basin. The thickness of the brine lake is about 80 m at its axis except at its southwestern end, where it is locally deepened to 200 m. The surface of the lake is at approximately 3462 corrected metres below sea level. The bathymetric form of the Atalante and Discovery basins are less well defined, because the steep slopes occurring close to the edges of individual swaths prevented the multibeam system from resolving the seafloor adequately. The brine lakes are not part of the same hydrogeological system. The brine-seawater interface is located at different water depths in the three basins. A sparker profile shows that the M reflector (commonly referred to as the top of the Messinian evaporitic sequence) outcrops on the steep SE side of the Urania Basin, thus, similarly to the Bannock and Tyro basins, a mechanism of dissolution of salts in seawater and downward surface flow of brine could be invoked to explain the origin of the lake. However, in the deep hole at its southwestern end the lake floor lies within the Messinian evaporites. The level of the Atalante brine lake is much higher than the position of the M reflector on the sides of the basin, thus the brine level must be sustained by a certain hydraulic head, either originated in the escarpment to the NW of the basin, or by over-pressuring of fluids at depth below the seafloor, and being expelled into the basin. The surface of each brine lake is shown well on sonographs obtained with TOBI, a deep-towed sidescan sonar with an operating frequency of 30 kHz, where the lake lies beyond the critical distance at which sound is totally reflected from the lake surface. In the absence of back-scattered sound from the seabed the lake surface looks black. Where part of the lake lies closer than the critical distance, refraction of the sound rays at the lake surface enables precritical rays to image the lake bed beyond the critical distance, but progressive reduction in amplitude as the incident rays approach the critical angle limits the distance beyond the critical distance at which clear images of the lake bed are obtained. Reinforcement from multiple raypaths gives the seabed around the lake edge a locally bright appearance. The temperatures of the brine lakes were measured on both the Urania and Discovery cruises with CTD (Urania only) and heat-flow probes. Temperature in the Urania Basin at 16.7°C is 2.4°C greater than in the seawater above. There is slight increase of temperature with depth in the lake to about 16.75°C. In the few metres immediately above the lake bed, temperatures rise to about 18°C. In the deep hole, the temperature just above the seabed is 28.4°C. In the Atalante Basin the brine is stratified into three layers. The top, 16 m-thick, layer has a temperature of 13.82°C, which is 0.26°C less than the seawater above. The middle,30m-thick, layer has a temperature of 13.91°C, and the bottom, 40m-thick, layer has a temperature of 14.06°C. The temperature in each layer increases gently downward. The chlorinity of the brine in the Urania basin is 120 g/l, compared with 22 g/l for the seawater. The chlorinity of the porewater in the sediment beneath the beds of the lakes is 55 g/l for the deep hole in the Urania basin, increasing with depth at 1 g/l/m, 140 g/l elsewhere in the Urania basin, decreasing at 7 g/l, 180 g/l for the Atalante Basin, with a constant concentration with depth, and 310 g/l for the Discovery Basin, decreasing at 12 g/l/m with depth. In the case of the Urania basin it appears that the lake is locally deriving brine from enriched sediment beneath, whereas elsewhere in the basin and in the Discovery Basin a high concentration brine fed laterally into the basin is permeating downward into the sediment beneath the lake floor. During the cruises several candidate basins were investigated for the possible presence of brine lakes within the area. Not all the possible basins were investigated, but even so three basins were discovered within a comparatively small area of the Mediterranean Ridge. If this is representative of their density of occurrence in this tectonic province of the Ridge, then we might expect that many more brine lakes exist in the Ridge. Do they offer a significant source of the salinity of the Mediterranean sea ?



[1] School of Earth Sciences, University of Birmingham, England. [2] Ecole Normale Supérieure, France. [3] IFREMER/Centre de Brest, France. [4] GEOMAR, Kiel, Germany. [5] Universita degli Studi Milano, Dipartimento Di Scienze Della Terra, Italy. [6] Osservatoria Geofisico Sperimentale, Italy. [7] Istituto Di Miniere E Geofisica Applicata, Universita' Di Trieste, Italy. [8] Istituto Di Oceanologia, Istituto Universitario Navale, Napoli, Italy. [9] National Centre for Marine Research, Athens, Greece.

G

SEDIMENTATION SETTING OF THE BLACK SEA

L. B. MEISNER, D. A. TUGOLESOV, Y. A BYAKOV
NIPlokeangeofizika, Krymskaya, Gelendzhik 353470, Russia

The Black sea basin is filled by Cenozoic sediments arranged in cycles of onlapping strata. The thickness of these sediments is 14 km.

On the data available in NIPlokeangeofizika, the Cenozoic sediments are represented by clays with bands of carbonates and sandstones (INITIAL. 1978). Among them the Maikopian sediments are represented mainly by clays, sandstones taking a small part of the total amount of rocks.

Deep or shelf nature of sedimentation setting is proved by some features, the most important of them is an old continental slope. We have designed for the Black sea a special technique of determination this old continental slope in the CDP seismic section (TUGOLESOV *et al.*, 1990). If we bear in mind this feature, the Black sea basins were deeep in the Eocene time already. Another good indicator of the good setting is presence of thick oblique bedding sediments, connnected with foredeltas. The same deltas occur in the Maikopian sediments. A complex dynamic picture of the sedimentation settings is typical of the Miocene time. From one hand, it was a depression of the Black sea basins, their extension, joining and formation of the entire basin. Thick submarine fans were discovered in the Miocene sediments in the periphery of the basin, which is an indirect index of deep sea. From another hand, the mountain structures rimming the Black sea were intensively growing at that time. Together with tectonic movements there were short-time and frequent eustatic sea level changes, which were recorded in the geologic section. In the Sarmatian section, along the northern flange of the Shatskiy ridge it was identified a cutting of the river bed, which testifies a sea level fall at this time. As for the Messinian time when a sharp fall of the sea level in the Mediterranean took place, there are no direct features which can prove the same fall in the Black sea. In the quaterny time, the formation of the deep basin of the Black sea was going on. All sediments were accumulated as a result of run-off of the rivers. The Danube was the main supplier of sediments, whose fans occupy a considerable part of the western half of the Black sea.

REFERENCES

Initial reports of Deep Sea Drilling Project, 1978, vol. XLII, part. 2, 1244 p.

TUGOLESOV D. A., GORSHKOV A. S., MEISNER L. B., 1990. Ancient slopes of the Black sea basin and associated breaks & unconformities. *Geologica Balcanic*, V. 20, n°1 : 3-18.

G

CLAYS DIAPIRS IN NEOGENE-QUATERNY SEDIMENTS OF CENTRAL SICILY : EVIDENCE FOR ACCRETIONARY PROCESSES

Carmelo MONACO and Luigi TORTORICI
Istituto di Geologia e Geofisica, Università di Catania, Italy

Neogene-Quaternary sedimentary sequences of the central Sicily exhibit characteristic horizons of chaotic clay, known as Argille brecciate, occurring at different stratigraphic levels. Five main horizons of Argille brecciate have been distinguished in the Tortonian-Lower Pleistocene sequences. These horizons have a thickness ranging between a few meters to a hundreds meters and are mainly made up of darkly brecciated clays containing exotic blocks. These horizons have been interpreted as large olistostromes linked to gravitational processes occurring on the slopes of the basin.

To better define the significance of these levels sedimentological and structural observations have been carried out on the horizons which occur within the Plio-Pleistocene sequences cropping out at the frontal part of the thrust belt. These levels are made up of dark-grey to brown clays showing a distinctive brecciated to cataclastic texture. These sediments, that usually contain re-worked Miocene microfaunas, include several blocks represented by volcanics and sediments belonging to the meso-cenozoic sequences involved in the Sicilian thrust belt. Volcanics are represented by alkaline basalts similar to those that characterize the mesozoic sequences of the Sicani domain, and by transitional basalts. Sedimentary blocks are made up of quartzarenites of the Numidian Flysch, glauconitic sandstones, varicoloured clays of the Sicilide units, reef limestones of the Panormide domain, Cretaceous marly-limestones and Miocene calcarenites belonging to the frontal units of the chain. Blocks of the Messinian sequence (Tripoli, evaporitic limestone and gypsum) and of the Lower Pliocene marly-limestones (Trubi) are also to be found.

These chaotic horizons occur as kilometric-long lens at the base of the major thrust sheets or as large intrusions showing typical flow-structures. These observations suggest that brecciated clays within the Plio-Pleistocene sequences may represent the results of mud diapirism occurring at the frontal part of an accretionary wedge. Their geometry, as well documented in several seismic profiles carried out along active accretionary complexes, reflects mud diapirs and mud ridges related to the frontal thrusts that during their emplacement have sampled different terranes of the accretionary complex and of the overlying slope sediments.

DEEP STRUCTURE AND DYNAMICS OF THE LITHOSPHERE-ASTHENOSPHERE SYSTEM IN THE MEDITERRANEAN REGION

St. MUELLER

Institute of Geophysics, ETH-Hoenggerberg, CH-8093 Zurich, Switzerland

In plate-tectonic terms the Mediterranean-Alpine region can be described as a broad transition zone between the African and Eurasian lithospheric plates which is outlined by the recent seismicity (Fig. 1). The present crust-mantle structure is the result of a dramatic evolution since the Early to Late Cretaceous with dynamic processes mainly governed by the counterclockwise rotation of Africa versus Europe which has led to an increasing lithospheric shortening from West to East (MUELLER and KAHLE, 1993). Superimposed on this large-scale dominant motion are regional tectonic deformations which are associated with compressive, strike-slip and extensional structures. The observational data available indicate that most of these features reach deeply into mantle and can only be understood as manifestations of processes involving the entire lithosphere-asthenosphere system.

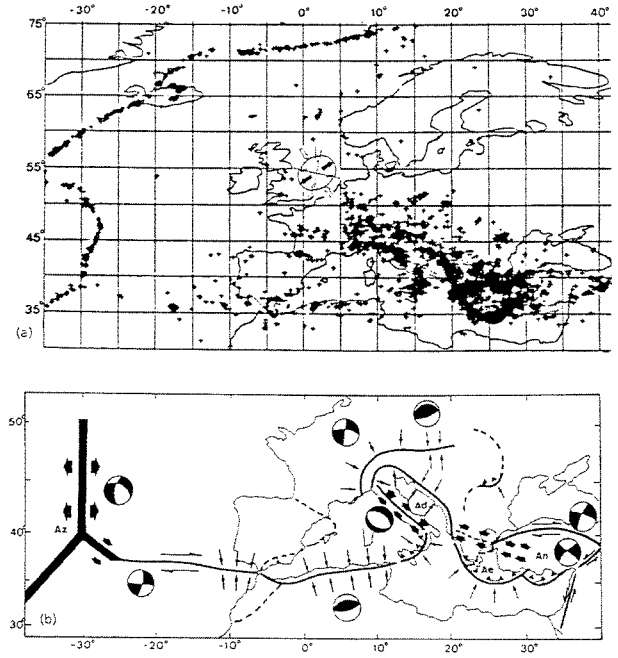


Figure 1: **(a)** The plate boundaries between N-America, Africa and Eurasia as outlined by the recent seismicity. The inset in the North Sea depicts a simplified seismotectonic stress scheme for central and NW Europe. **(b)** Generalized plate boundaries and seismotectonic stress patterns in the E-Atlantic as well as in the Mediterranean and Alpine region (after MUELLER, 1989). **Ae** = Aegean plate; **An** = Anatolian plate. **Az** = Azores triple junction; **Ad** = Adriatic promontory (or Apulian "microplate").

An attempt has been made to present a summary of the dominant structural and dynamic features which characterize the broad transition zone between the two major plates (Fig. 1). The multidisciplinary synthesis is based on the most recent geophysical and geodetic data for the Mediterranean-Alpine region. It can be demonstrated that - superimposed on the large-scale counterclockwise rotation of the African plate - complex seismotectonic processes affecting the lithospheric fragments between Africa and Europe play an important role. Their dynamics is triggered by thrusting, transcurrent motions, rifting and back-arc spreading associated with seismicity. Examples of regional cross-sections illustrating lateral heterogeneities of the upper-mantle structure are derived from the dispersion analysis of seismic surface-waves, the tomographic inversion of P- and S-wave traveltimes, long-range seismic refraction profiling and deep-reaching near-vertical reflection surveys. Beneath a highly differentiated crustal structure pronounced lateral variations of seismic wave velocities are indicative of abruptly changing features in the upper mantle. Based on space-geodetic data obtained as part of the WEGENER-MEDLAS Project within NASA's worldwide Crustal Dynamics Project (CDP) it has been possible for the first time to define in more detail the active tectonic framework by very-long baseline interferometry (VLBI), satellite laser ranging (SLR) and at the same time to aim at resolving in finer detail the kinematics of active earthquake belts by densifying the network of existing GPS measurements. In hazardous areas either continuous monitoring or repetitive measuring campaigns at shorter time intervals should now be carried out. This would allow to finally determine the space and time variations of the regional strain and stress tensors.

The results available so far have illustrated that intra-lithospheric detachment and wedging phenomena (MUELLER, 1990), differential rotations and strongly variable deformation rates have shaped the present tectonic appearance of the Mediterranean-Alpine realm. They quantitatively substantiate ongoing crustal movements (of up to 50 mm per year), such as the present northward motion of the Arabian plate, the westward motion of the Anatolian plate, the back-arc spreading in the Aegean sea and the subduction along the Hellenic arc. It could be shown that the plate contact in the Western Mediterranean region is primarily under a SE-NW compressive stress leading to a lithospheric shortening of 4 mm per year in the west to 9 mm per year in the northern Ionian sea. There is now sufficient evidence that the entire lithosphere-asthenosphere system is involved in these deep-reaching processes which significantly contribute to the potential hazard associated with impending earthquakes and volcanic eruptions.

REFERENCES

MUELLER St., 1989. Deep-reaching geodynamic processes in the Alps. *in:* Alpine Tectonics (edited by M.P. Coward, D. Dietrich and R.G. Park). Spec. Publ. Geol. Soc. London, 45: 303-328.

MUELLER St., 1990. Intracrustal detachment and wedging along a detailed cross-section in Central Europe, *in:* Exposed Cross-Sections of the Continental Crust (edited by M.H. Salisbury and D.M. Fountain. NATO-ASI Series (Kluwer Acad. Publ., Dordrecht, The Netherlands), C 317: 623-643.

MUELLER St. and KAHLE H.-G., 1993. Crust-mantle evolution, structure and dynamics of the Mediterranean-Alpine region, *in:* Contributions of Space Geodesy to Geodynamics: Crustal Dynamics (ed. D.E. Smith and D.L. Turcotte). American Geophys. Union, Washington, D.C., Geodyn. Ser., 23: 249-298.

IONIAN BASIN DEEP CRUSTAL STRUCTURES AND ITS WESTERN MARGINS

R. NICOLICH[1], F. AVEDIK[2], L. CERNOBORI[3], A. HIRN[4] & STREAMERS/PROFILES Working Groups

[1] DINMA-Univ. of Trieste, via Valerio 10 TS Italy

[2] IFREMER Brest, France

[3] CNR-Ist. Talassografico Trieste, Italy

[4] I.P.G. de Paris, Pl. Jussieu 4, Paris, France

In the Ionian basin the discussion about the crustal structure had to relay on moderate penetration seismic of the seventies, limited by the source power and by the low coverage (FINETTI, 1982). The vertical reflection seismic was supplemented with spatially averaging refraction velocity-depth measurements with OBS or ESP techniques (MAKRIS *et al.*, 1986; FERRUCCI *et al.*, 1991; DE VOOGD *et al.*, 1992; TRUFFERT *et al.*, 1992). The principal scientific problem to address to is wether the Ionian basin has an oceanic crust or a highly attenuated continental crust. The second topic is the nature of the Ionian basin with respect to its margins.

In our multichannel reflection profiles it is clearly recognisable a band of "layered" high amplitude reflections near the base of the crust, which appears to be the characteristic of the basin. This band shows a quasi-monochromatic (ca. 8 to 10 Hz) frequency of the layering. There is some evidence to suggest that the low frequency band dips down, towards the Malta Escarpment (ME) structures, where the crustal image changes and a clear thickening towards the West appears: landward dipping reflectors separate continental and intermediate crust in the central sector of the ME. There are some similarities with the Gulf of Lions deep seismic profile (DE VOOGD *et al.*, 1991).

The time deepening of the lower crust and Moho in front of the margin of the southern Calabria can be partially due to the velocity pull-down of the sedimentary pile of the arc. In fact a true dip of approximately 15% to 18% over 60 km distance is documented. Moreover the reflecting band maintains its characteristics of reflectivity and thickness till its abrupt termination beneath the Ionian extension of the Calabrian crustal structures.

An unexpected thinning of the crust towards the continent has been revealed by the seismic profiles bordering the Sicilian margin (northern sector of the ME). This important feature seems to be directly related to the presence of the volcanic products in the Hyblean plateau and to the actual volcanism of Mt. Etna.

The data were acquired in the frame of the project named STREAMERS with the financial support of EEC. The survey was afterwards completed with the lines acquired in front of Etna (project ETNASEIS) and, thanks to a further project named PROFILES, the data processing was completed and improved. In the data acquisition we used a 7118 cu.in. tuned air-gun source and a 4.5 km streamer giving us the possibility of a high coverage (4500%). In a second time a single-bubble GI-airgun source with a streamer of only 3000 m and a 24 fold coverage was employed (AVEDIK *et al.*, 1994). Equivalent results were obtained, which include: the penetration through the whole crust of the Ionian sea, the resolution of the deep frame of the basin at the margins, hints regarding the sediment/lower crust relations and the accomplishment of coincident and wide-angle acquisition with sea-land connections and landward extension of the marine coverage. Processing advances include the first sea-bottom multiple cancellation by removal of coherent events, the array simulation, an adaptive AGC.

Abyssal plain and central sector of the ME. South of the Alfeo sea-mount we enter into the Ionian Abyssal Plain with the presence of the Messinian salt and thick pre-evaporitic layers. The pinching out of the upper seismic sequences testifies the importance of the post-Tortonian tectonic evolution of the ME and of the facing area with intermediate crustal structures(CASERO *et al.*, 1988). An initial crustal arching may be recognised with a Moho at depths of 16-17 km and newly formed sin-rift basins record the Pleistocene tectonic reactivation: vertical displace ments and transcurrencies.

Messina rise and the northern sector of the ME. The region is largely occupied by the sea extension of the Hyblean foreland. The recent uplift (of the order of 2 mm/y) of the margin is documented by syn-rift basins and vertical faults cutting the whole crust. The extensional tectonic and the pronounced crustal arching have completely obliterated the collisional features of the Calabrian arc in this region. The evidence for tension is consistent with the abundant volcanism of the Mt. Etna occurring preferentially near locations where major fracture zones are thought to transect the crust which thicks only 15 km.

The Ionian margin of southern Calabria. The lines show the sea ward extension of the Calabria block, the internal structures of the crystalline crust down to the base at about 21-22 km depth and the piggy-back basins developed on the arc. The flexures of the Ionian crust in the Spartivento basin area correlate with the deep refraction data. Its abrupt termination, seen in the seismic lines, can be related to a poor signal/noise ratio or is an effect controlled by a sharp velocity increase beneath the overlapping Calabrian crustal structures. Tectonic discontinuities cannot be excluded.

REFERENCES

AVEDIK F., NICOLICH R., HIRN A., MALTEZOU F., McBRIDE J., CERNOBORI L., 1994. Appraisal of a new low frequency seismic pulse generating method on a deep seismic reflection profile in the Central Mediterranean sea. First Break (submitted).

CASERO P., CITA M. B., CROCE M., FRISIA S., HIEKE W. and NICOLICH R., 1988. Malta Esc., Alfeo sea-Mount and Victor Hensen sea-Hill: a key to plate tectonic evolution of the Eastern and Western Med. since Mesozoic. ODP proposal presented at ECOD & CIESM WG.

DE VOOGD B., NICOLICH R., OLIVET J.-L., FANNUCCI F., BURRUS J., 1991. First deep reflection transect from Gulf of Lions to Sardinia. AGU, *Geodyn. Series*, 22, 265-274.

DE VOOGD B., TRUFFERT C., CHAMOT-ROOKE N., HUCHON P., LALLEMANT S. and LE PICHON X., 1992. Two-ships deep seismic soundings in the basin of the Eastern Med. sea (Pasiphae cruise). *Geophysical J. Int.*, 109, 536-552.

FERRUCCI F., GAUDIOSI G., HIRN A. and NICOLICH R., 1991. Ionian basin and Calabrian Arc. *Tectonophysics*, 195, 411-419.

MAKRIS J., NICOLICH R. and WEIGEL W., 1986. A seismic study in the Western Ionian sea. *Annales Geophysicae*, 4, 36, 665-678.

FINETTI I., 1982. Structure, stratigraphy and evolution of Central Mediterranean. *Boll. Geof. Teor. Appl.*, XXIV, 96, 247- 312.

TRUFFERT C., CHAMOT-ROOKE N., LALLEMANT S., DE VOOGD B., HUCHON P. and LE PICHON X., 1993. The crust of the Eastern Med. ridge from deep seismic data and gravity modelling. *Geophysical J. Int.*, 114, 360-372.

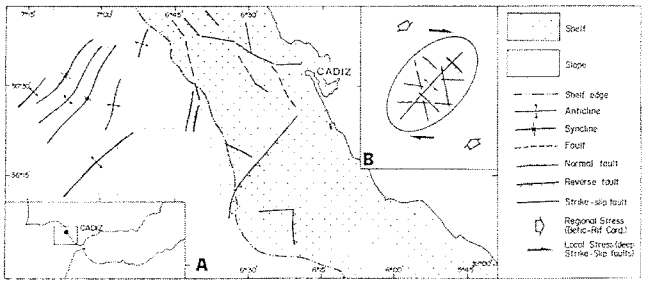
G

TECTONICS OF THE GULF OF CADIZ AND THE WESTERN END OF THE MEDITERRANEAN ALPINE BELTS

PALLARES L.[1], ALDAY, F.[1] and MALDONADO A.[1,2]

[1] Depart. de Geodinámica, Univ. de Granada. [2] Inst. Andaluz de Geología Mediterranea (C.S.I.C./Univ.de Granada). C/Fuentenueva s/n. 18002 Granada, Spain.

The Gulf of Cadiz includes the westernmost sector of the External Zones of the Betic-Rif chains, where the Gibraltar arc bends to develop an arcuated orogenic belt plunging westward. The continental margin of the gulf consists of three main tectonic provinces which concentrically surround the internal zones of the arc. These include the flysch units of the Campo de Gibraltar Complex in the proximity of the strait of Gibraltar, the Betic-Rif external zones, and the Neogene basins of the Guadalquivir Valley which extends southwestward and occupies most of the central sector of the Gulf of Cadiz. The area could be defined as a type of Mediterranean fore-arc basin. Two areas, NW and SE, are identified in the continental shelf, characterized by the absence or presence of shallow acoustic basement formations. The basement in the NW sector is restricted to a narrow zone close to the coastline, while the overlying Cenozoic deposits show significant seaward thickening. The basement, in contrast, crops out over large areas in the SE sector of the shelf, and it is locally drapped by a thin veneer of recent deposits. The Cenozoic formations are only observed in this sector in the most external parts of the shelf. The basement is composed of fault-bounded blocks of flysch and subbetic units, individualized by major tectonic surfaces, which may be correlated with the Gibraltar Thrust. The morphological characteristics of shelf are influenced by the tectonics lineaments, since the main boundaries coincide with faults affecting the basement in the SE sector and the development of fault bounded basins in the other sectors of the margin (figure).



Northwestern shelf. The inner and central sector of the NW shelf is characterized by three fault sets striking NNW-SSE, NW-SE and E-W, which affect the basement. The first and third group indicate a predominant strike-slip development, while the second group is a complex of normal faults, some of which correspond to growth faults, that may also have strike-slip component. All these faults have been active during the Quaternary, with a significant proportion showing Late Quaternary and even present displacement. Some faults, however, are interpreted reactivated Pliocene and Miocene fractures. The outer shelf contains faults with NNW-SSE and N-S directions, which intersect the edge of the shelf. These are generally normal faults, some of which appear to have a strike-slip component and locally showing reverse drag. The most recent displacements are from the Middle or Early Quaternary, therefore older than in the faults of the middle and inner shelf. Some of these faults are associated with diapirs which show more recent displacements.

Southeastern shelf. The SE sector of the Gulf of Cadiz shelf is very different from the NW sector. The shallowness of the acoustic basement and the absence of a significant depositional cover difficult the identification of faults and only the most significant frac-tures have been represented (figure). This sector is bounded to the N and W by an inverse fault, which cuts oblique across the shelf in a NE-SW direction, bending southward in the southern sector. Another, probably reverse fault running N-S lies to the SE of the above fault, in the middle-outer shelf sector (figure). The northern fault facilitates the westward extension of the shelf, where it reaches it maximum width. The southern fault bounds the basement formations and delineates the limit of the Cenozoic depositional units onlapping the basement. The northern fault was active in the northern sector from the Pliocene to the Late Quaternary, in the central zone during the Late Pliocene, and in the southern end from Late Pliocene to Early and Middle Quaternary. The southern fault was active during the same last period. The orientation, age and kinematic of these faults suggest the last compressive stages of the Betic-Rif orogene and its westward thrust.

The Slope. The most prominent tectonic elements of the slope are open folds with a NE-SW axis, slightly curved and subparallel. They could represent the near-surface expression of deep wrench faults with an approximate orientation of E-W to ESE-WNW (figure). These structures are coherent with the fault system described in the NW shelf. The existence of deep faults in this region, however, have not been clearly demonstrated at present. Recent works based on the solution of focal mechanisms indicate a diffuse area of seismicity eastward of Gorringe Bank, which probably follows the boundary between major crustal elements. One branch of this presently active area extends into the Gulf of Cadiz and may be represented by the suggested E-W to ESE-WNW strike-slip faults.

The distribution and characteristics of the acoustic basement and the structures of the continental margin of the Gulf of Cadiz differentiate two sectors in the shelf. The northwestern sector is characterized by distensive features subparallel to the coast, which are associated with subsidiary faults of predominant strike-slip component. These faults facilitate the seaward subsidence of the shelf and the development of thick Cenozoic depositional units. The structure of the southeastern shelf, in contrast, is controlled by a compressive regime, which develops fault bounded blocks of the acoustic basement and constrains the development of large depositional basins. The curved-axis, NE-SW trending folds of the slope are congruent with the existence of deep wrench faults E-W to ESE-WNW oriented, and with the faults in the NW of the shelf. It may be postulated that the structures in the Gulf of Cádiz are compatible with wrench zones with a dextral sense involving both dip-slip and strike-slip components, caused by deep faults associated with a broad deformation zone. This zone may corresponds to a branch of the boundary defined by the continuing collision of the African and Eurasian plates. The observed structures and inferred tectonics in the Gulf of Cadiz are compatible with those observed in the Betic cordilleras characterized by a NNW-SSE compression.

THE MCS PRISMED CRUISE, PART 2 : THE INNER MEDITERRANEAN RIDGE, THE HELLENIC TRENCH AND MARGIN

Henrik Hove PEDERSEN[1], Eric CHAUMILLON[2] and Jean MASCLE[2]

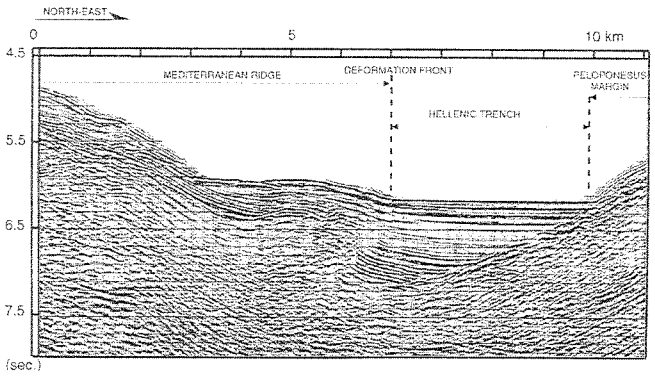
[1] Geosciences, Aarhus Universität, 8000 Aarhus, Denmark
[2] GEMCO - Laboratoire de Géodynamique Sous-Marine, B.P. 48, 06230 Villefranche sur mer, France

The multichannel seismic reflection survey Prismed (March 1993) has yelded new data on the geological structures of the northern Mediterranean Ridge (M.R.) and of its contacts with the Hellenic trench and bordering Aegean margin. These areas are of major interest to study the transition betwen extensional and compressional regimes.

1 - Off Peloponesus, the M.R. contains a thick, likely Messinian, basin affected by gentle folding and reverse faulting ; only few deformations are detected within the Plioquaternary cover. In opposition the contact between the M.R. and the bordering Matapan trench is characterized by reverse faulting and compressional deformations involving recent sedimentation. We interpret these features as evidences of transpressional activity related to dextral strike slip motion at the boundary between the trench and the M.R. In the area the continental margin is cut by extensional faulting that has likely reactivated previous thrust zones.

2 - South of Crete, the margin is cut into a series of imbricated and tilted blocks resulting in fan-shaped basins only covered by thin, unconformable plioquaternary sediments. There, the M.R. appears bounded by northward directed thrust zones ; however the 3000 meters deep trench represents the northern limit of major gravitational sliding over parts of the lower continental margin.

3 - Finally, south-east of Crete the Hellenic trench system divides into two branches ; the northern Pliny trench may correspond to en echelon strike slip reactived former major thrusts across continental margin blocks ; the southern Strabo trench represents the northern limit of M.R. related sedimentary sliding.



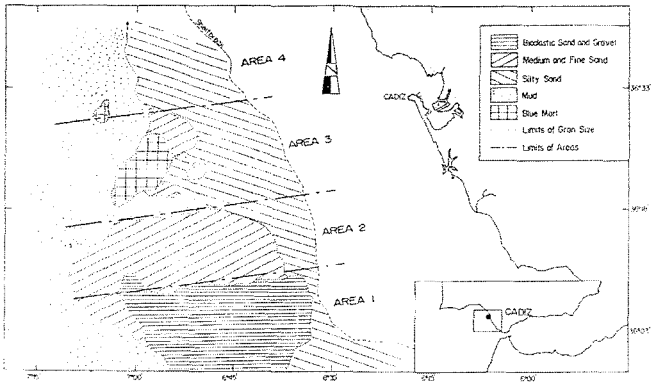
The M. R inner deformation front facing the Peloponesus margins

BOTTOM SEDIMENT DISTRIBUTION IN THE GULF OF CADIZ SLOPE INFLUENCED BY THE MEDITERRANEAN UNDERCURRENT

RODERO J.[1] and MALDONADO[1,2] A.

[1] Instituto Andaluz de Geología Mediterránea, CSIC. C/Fuentenueva s/n 18002.
[2] Depart. de Geodinámica, Universidad de Granada. C/Fuentenueva s/n 18002. Granada, Spain

As a result of the opening of the strait of Gibraltar at the end of the Miocene, the connections between the desiccated Mediterranean sea and the Atlantic ocean were stablished with circulation patterns probably similar to the present (MALDONADO, 1992). The interaction between different water masses resulted in a complex current system in the Gulf of Cádiz continental margin, which influenced sediment distribution and depositional patterns (NELSON *et al.*, 1992). One of the main controlling factors of the sediment distribution in the Gulf of Cádiz is the interplay of several water masses at different depths in response to the circulation patterns of the flows from the Mediterranean and the Atlantic water masses (HEEZEN and JOHNSON, 1979). The flow from the Mediterranean is known as the Mediterranean undercurrent, which is characterised by high salinity, resulting in a more dense water mass than the colder Atlantic waters. As it leaves the strait of Gibraltar, the Mediterranean undercurrent flows between 200 and 1800 m water in a WNW to NW direction along the continental margin of the Gulf of Cadiz, influencing particularly sediment distribution along the shelf brake and upper slope. The predominant Atlantic water flow, in contrast, follows the continental shelf in a ESE to SE direction to enter the Mediterranean sea through the strait of Gibraltar.



The Mediterranean undercurrent decreases in speed as it moves NW, away from the strait of Gibraltar. The speed ranges between maximum velocities of 250 cm/s (KENYON and BELDERSON, 1973) to 181 cm/s (AMBAR and HOWE, 1979) near the strait, to 10-20 cm/s in the central sector of the Gulf of Cadiz. This decrease in energy results in a distinct gradation of sediment types in the margin. Four main areas have been identified in the continental margin on the basis of the grain-size distribution :

Area 1. This area occupies the southernmost sector of the Gulf of Cadiz. It is characterised by bioclastic sand and gravel, developed as a lag deposit due to the erosion and transport of the finer, terrigenous fraction by the strong Mediterranean undercurrent. There are also locally outcrops of the basement, without sediment cover due to the strong bottom current. These sediments deposits develop several types of bedforms (NELSON *et al.*, 1992).

Area 2. This area extends to the north of Area 1, near the central sector of the Gulf of Cadiz. The predominant grain size is medium to fine sand, although there is also a significant proportion of bioclastics components of finer grain-size than in Area 1. The bedforms are characterized by mass-gravity flows, probably influenced by both, the Mediterranean undercurrent and down-slope flows.

Area 3. This area occupies the central sector of the Gulf of Cadiz. The bottom morphology is very complex and it is characterized by topographic ridges and canyons, oriented perpendicularly to the margin and subhorizontal platforms at several depths in the slope. The distribution of sediment types, in consequence, is controlled by the location of the topographic irregularities in respect to the Mediterranean undercurrent and the location of submarine canyons. In the areas exposed to the Mediterranean undercurrent the predominant grain-size is fine sand, while in protected areas dominates silty sand and finer materials..

Area 4. The Area 4 occupies the northern sector of the study region. It is characterised by clavely silts and silty clays, reflecting the significant decrease in energy of the Mediterranean undercurrent. The deposits develop locally contour bodies in the vicinities of the topographic irregularities

The northwestward variation in grain-size is also reflected by a host of bedforms which also record the decrease of energy of the Mediterranean undercurrent (NELSON *et al.*, 1993). Thus, sand dunes occur in the southernmost area, large mud waves are found to the West as the grain size diminishes, and large contoured bodies are observed in the northernmost regions.

REFERENCES

BARAZA J. and NELSON H., 1992. Clasificación y dinámica de las formas de fondo en el Golfo de Cádiz: implicaciones de la corriente profunda mediterránea en los procesos sedimentarios durante el Pliocuaternario. III Congreso Geológico de España y VIII Congreso Latinoamericano de Geología. Tomo 1: 118-122.

GUTIERREZ-MAS J. M. and VILLANUEVA GUIMERANS P., 1986. Estudio granulométrico y geoquímico de los sedimentos recientes no consolidados de la plataforma continental próxima a Cádiz. III Seminario de Química marina. Cádiz, 28, 29 Enero 1986.

HEEZEN B. C. and JOHNSON G. L., 1969. Mediterranean undercurrent and microphysiography west of Gibraltar. *Bulletin Institut Oceanographique*. Monaco, 67 : 1-95.

MALDONADO A., 1992. Alboran sea. *Geo-Marine Letters*, Springer International, New York, v.12 (2-3) p.61-186.

NELSON H. *et al.*, 1993. Mediterranean undercurrent sandy contourites, Gulf of Cadiz, Spain. *Sedimentary Geology*, 82: 103-131.

PALANQUES A. *et al.*, 1986-1987. Estudio de la materia en suspensión en el Golfo de Cádiz. Acta Geológica Hispánica t.21-22: 491-497.

FROM THE TYRRHENIAN TO THE IONIAN DOMAIN : DIFFERENT MODE OF BASIN FORMATION

Marco ROMANELLI[1], Carmelo MONACO[2], Rinaldo NICOLICH[1] and Luigi TORTORICI[2]

[1] DINMA, Università di Trieste, Italy
[2] Istituto di Geologia e Geofisica, Università di Catania, Italy

One of the peculiar features of the central Mediterranean is represented by the occurrence of stretched areas developing at the rear of mountain belts. The Tyrrhenian sea, the most recent of these basins, has been developing since the Tortonian time up to the present. The geodynamic significance of the Tyrrhenian domain and its relations with the Calabrian arc and, consequently, with the Ionian domain are still debatable. The Tyrrhenian domain is, in fact, interpreted as a back-arc basin related to the subduction of the Ionian domain underneath the Calabrian arc or as a stretched area as a result of the astenosphere domal uplift. Finally, it is interpreted as an asymmetric passive rifting developed as a consequence of the N-S collision between the African and European plates.

In order to test these different hypotheses, the structural setting of sedimentary basins which occurr along a transect extending from the southern Tyrrhenian sea (Marsili basin) to the Ionian domain (external front of the Calabrian arc) has been analyzed. This study, supported by the analyses of several reflection and refraction seismic profiles and by stratigraphic, sedimentological and structural data carried out on the onshore Neogene-Quaternary basins of the Calabrian arc, points out a complex interplay between extensional and compressional processes that governs the geodynamic evolution of this region.

Along the studied transect three main types of sedimentary basins have been recognized. The first is related to rifting processes and develops above a thinned continental and/or oceanic crust. On the contrary, the second type is related to underplating processes developing above accretionary wedge domains or on the frontal portion of the crustal backstop. Finally, the third type of sedimentary basin is related to accomodation processes occurring at the rear of the accretionary wedge in ored to maintain its stable geometry in response to the underplating. These different basins, developed in space and time, are superimposed on each other suggesting an overall southeast migration of the geodynamic processes which govern the whole system.

In addition, a carefully analysis of these data together with geophysical and structural information on the active tectonics characterizing this region allow us to infer that the process responsible for the opening of the southern Tyrrhenian sea and therefore for the development of the sedimentary basins is at present inactive.

G

AGE CONSTRAINTS AND ORIGIN OF THE MARSILI DEEP BASIN'S FLOOR (TYRRHENIAN SEA)

Carlo SAVELLI[1] and Anatoly A. SCHREIDER[2]

[1] Istituto per la Geologia Marina-CNR, Via Gobetti 101, 40129 Bologna, Italy
[2] Shirshov Inst.of Oceanology, Russian Ac. of Sciences, Moscow 117218, Russia

The deep basin of Marsili in the SE Tyrrhenian sea is a subcircular, very young structure floored with basaltic crust. The central part of the structure is occupied by the Marsili volcano, the largest of the Tyrrhenian seamounts (55 by 25 km and about 3 km high). The volcano's top is at the depth of 485 m. Results of the drill hole 650 (Leg 107 of the Ocean Drilling Program) indicate that hole bottom volcanism occurred during the chron C2 (Olduvai event; 1.78 - 2.02 Ma along the western margin of the Marsili basin. Lavas from the volcano's top have K/Ar age of <0.2 Ma.

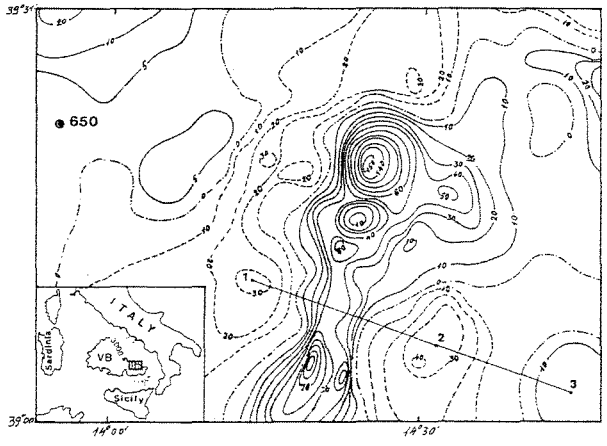


Fig.1- Magnetic anomaly field. Continuous lines =positive isodynams; dashed =negative; dashed-dotted =zero isodynams based on data from PINNA *et al.*, (1987) and BELIAIEV *et al.* (1991).

The basaltic seafloor originated in an intra-orogenic back-arc setting. Important information for a conceptual framework of the origin of basement and of seamount in study can be obtained by the geological-geophysical interpretation of magnetic data. The geomagnetic field of Marsili seamount is represented by positive and negative anomalies which have either elongated or subcircular configurations (Fig. 1). The elongated intense magnetic high with maximum intensity of 1500 nT correlates with the morphological axis of Marsili seamount. In the West margin of the basin at a distance of 40-45 km from Marsili physiographic axis, there is an overall round-shaped high of the magnetic field with intensity of 100 nT near to the 650 Site. To the East, at an approximate distance of 35 km from the ridge axis another round-shaped positive anomaly occurs which has intensity of 100 nT. The opening process may have started with diffusional spreading in the basin's margins. Growth of the basaltic crust with time from the borders to the central parts of the basin can be characterized by the changing of magnetic patterns. The quasi-linear forms of the subsequent magnetic patterns seem to be associated with better organized fractures cracking the thin, weak parts of the lithosphere. Propagation of short extension fractures (short speading axes) into the adjoining lithosphere's sectors is impeded by increase of the lithosphere thickness. In such conditions, high rates of magma supply lead to formation of large volcanic seamounts like the Marsili. With time, the linear fractures feeding axial volcanoes estinguish. The increasing loads of thick lava piles reduce and finally stop the eruptive activity of the edifices. The geodynamic history of the Tyrrhenian sea is characterized by migration of large axial volcanoes from the West to the East, from the mature, estinguishing edifices to young ones in new weak zones of thin lithosphere. Basalt and andesite rocks were obtained only from the Marsili seamount's portions associated with the positive anomaly. The mean values of magnetic susceptibility (9 x 10-3 SI), remanent magnetization (10 A/m) and Koenigsberger ratio (50) of the recovered lavas are high. The figure 2 shows the geomagnetic age model of Marsili volcano based on 3D modelling of the magnetic field. K/Ar dating indicates that the positive magnetized body of Marsili was erupted in the period of the Brunhes positive polarity epoch (Chron 1; 0-0.78 Ma). It is possible that the two negative magnetized areas at the footsteps of the volcano and surroundings consist of products erupted during the Matuyama polarity epoch (C1r; 0.78-1.78 or C2r; 2.02-2.64; Fig. 2). No rocks have been recovered by dredging and coring from these areas. Here, such sampling is very difficult or impossible because of the occurrence of thick sediment (about 100 ms). The mode of formation of Marsili seamount and of its basement are open problems. It is not known what are the age and nature of the volcanites associated with the negative anomalies. New drilling results in the volcano footsteps will serve to ascertain whether these rocks belong to the same chron, or not. This will provide important evidence in favor or against volcanic spreading in the case of Marsili. To obtain such evidence we discuss two drill targets which both are in areas of maximum intensity of the negative magnetic anomalies (Fig. 1). Their coordinates are the following: 39'10.6N-14'13.9E; 39'05.5N-14'31.1E. We discuss a third drilling target to reach basement rocks in the area of positive magnetic anomaly along the basin's eastern margin (39'01.9N-14'44.8E; Fig.1) possibly associated with early diffusional spreading. The principal problem which can be solved by drilling into these rocks is the following: does basaltic basement in this marginal Site of the basin belong to the Olduvai subchron like the basement of Site 650, or not ?

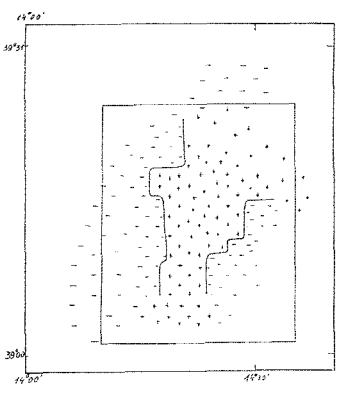


Fig.2- Distribution of the positive (Brunhes) and negative (Matuyama?) magnetized bodies.

NATURE ET DISTRIBUTION DE LA MATIÈRE ORGANIQUE DANS LES DÉPÔTS SUPERFICIELS DU GOLFE DE TUNIS (TUNISIE)

Nouri SOUSSI[1] et François GADEL [2]

[1] Faculté des Sciences de Tunis, Campus Universitaire 1060 Tunis , Tunisie

[2] Laboratoire de Sédimentologie et Géochimie Marines, Université de Perpignan, 66860 Perpignan, France

L'approche géochimique peut offrir des informations complémentaires dans la compréhension des mécanismes sédimentaires. Dans ce travail, nous aborderons l'étude de la distribution et de la nature de la matière organique ainsi que la répartition de quelques métaux contenus dans les dépôts afin de préciser certains processus dynamiques qui sont à l'origine de la mise en place des différents faciès sédimentaires.

La répartition du carbone organique (CO) dans les dépôts superficiels marque bien l'individualisation de deux prodeltas de l'oued Mejerda correspondant à l'ancienne embouchure (sud de Ghar el Melah) et la nouvelle embouchure (Kalaât el Andalous). Dans le petit Golfe, on note un enrichissement en CO dans sa partie médiane. Les teneurs en azote (N) font apparaître l'individualisation de deux domaines distincts. Le premier correspond à la partie occidentale marquée par des teneurs en azote inférieures à 0,1% et C/N > 10 et parfois > 20 dans la zone prodeltaique (materiel évolué). Le second correspond au reste du golfe qui présente des teneurs en azote > 1% jusqu'à 1,5% dans la dépression centrale et un rapport C/N < 10. Les rapports carbone hydrolysable CH / CO sont généralement > 40 ; cependant il faut noter que dans les prodeltas et dans la dépression centrale, ce rapport est > 50. Dans la première zone, il est possible que l'augmentation de CH/CO soit liée aux sucres d'origine continentale (polysacharides) alors que dans la deuxième, elle est liée à l'origine marine de la matière organique (composés azotés).

L'étude des matières humiques (MH) a montré que les taux d'extraction sont généralement homogènes, compris entre 20 et 30%. Les valeurs sont relativement faibles traduisant un matériel ayant perdu des fractions solubles.

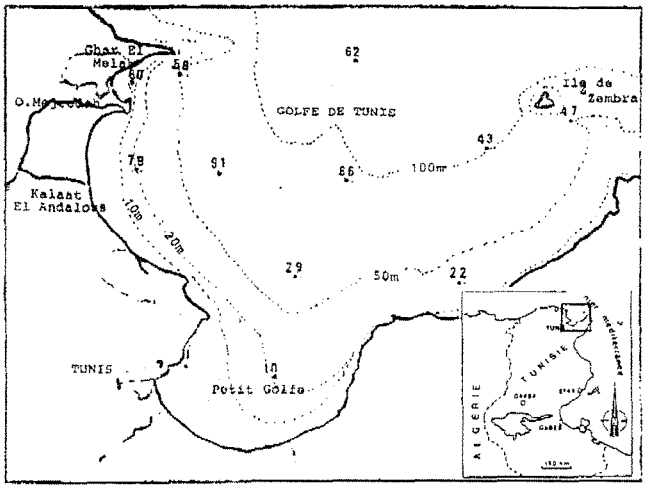
Les rapports Acides Fulviques (AF)/Acides Humiques (AH) sont généralement faibles compris entre 0,1 et 0,2 ce qui dénote une matière organique très évoluée. Les rapports les plus élevés se situent dans la zone prodeltaïque où CH/CO est d'ailleurs le plus fort (matériel plus frais). Le diagramme de VAN KREVELEN établi pour les différents échantillons montre que les échantillons analysés se répartissent selon deux ensembles. Le premier ensemble montre beaucoup d'affinités avec les sédiments marins (stations 47, 58, 62 et 43). Le deuxième ensemble se situe entre les sols terrestres et les sédiments marins (stations 79, 91, 60 et 22).

L'analyse des spectres infrarouges a permis de reconnaître les caractères suivants :

- le caractère continental est bien marqué par la faible intensité des bandes aliphatiques sur les stations 10, 58, 60, 79 et 91, alors que dans les stations 43, 47, 62, 66 et même 22 et 29, le caractère marin prédomine (bandes plus accusées),
- les bandes correspondant aux sucres (1050 cm^{-1}) sont assez bien développées sur l'ensemble des échantillons analysés, cependant elles sont plus marquées dans les AF des stations de la dépression centrale 47 et 66,
- les bandes amides (1540 cm^{-1}) sont généralement faiblement développées dans les AH,
- les groupements carboxyliques COOH correspondant à la bande 1710 cm^{-1} bien que peu marqués, sont plus développés sur les stations de la zone prodeltaïque (caractère acide de la matière organique continentale).

Il apparaît donc que dans les dépôts superficiels du golfe de Tunis la matière organique est essentiellement d'origine continentale, marquant l'influence majeure de l'oued Mejerda dans l'alimentation du golfe en matériel détritique; l'influence marine n'est reconnue que dans la dépression centrale et dans les environs de l'Ile de Zembra.

Ces résultats s'accordent avec la distribution des métaux lourds notamment le Pb, le Zn et le Cu, issus de cet oued qui se trouvent surtout concentrés dans les zones prodeltaïques avec des teneurs respectives de l'ordre de 70, 80 et 12 ppm. L'enrichissement des sédiments du golfe en métaux lourds résulte essentiellement de leur complexation avec la matière organique et la fraction argileuse, notamment dans la zone prodeltaïque, favorisée par les phénomènes de floculation.



Le golfe de Tunis : localisation des échantillons analysés

EXTRUSION TECTONICS IN THE CENTRAL MEDITERRANEAN

Luigi TORTORICI[1], Carmelo MONACO[1], Rinaldo NICOLICH[2] and Marco ROMANELLI[2]

[1] Istituto di Geologia e Geofisica, Università di Catania, Italy
[2] DINMA, Università di Trieste, Italy

The central Mediterranean is an intricate geological puzzle in which extensional and compressional processes have developed in a short time span, from the Tortonian up to the Quaternary times. Stretched areas, crustal underplating and a thrust belt system forming tight arc-shaped structures are, in fact, the peculiar features of this region. Nevertheless, geophysical and structural data allow us to distinguish distinct crustal domains separated by large strike-slip faults whose kinematic evolution was strictly controlled by the N-S collisional processes occurring between the African and European plates. The main recognizable crustal domains of the area are represented by :
1) the Pelagian block that exhibits a normal continental crust affected by small rifting processes (Strait of Sicily Rift Zone),
2) the stretched areas of the southern Tyrrenian and Ionian domains characterized by a thinned continental or oceanic crust,
and 3) the orogenic belt represented by the Apennines and Maghrebian thrust system and by the Calabrian arc that shows a complex interaction between the crusts of different domains.

The structural pattern of different crustal blocks, the kinematics of the strike-slip fault boundaries together with a careful analysis of the timing of deformation, suggest that the Neogene to Quaternary tectonics of the central Mediterranean is the result of the lateral extrusion of the Calabrian arc towards East as a response of the progressive N-S impingement of the continental indenter of the Pelagian domain. Rates of deformation also suggest how this process may have triggered astenospheric domal uplift in the stretched areas of the southern Tyrrhenian sea, which brought a faster lateral extrusion of the Calabrian arc.

MUD VOLCANOES AND BRINE POOLS ON THE MEDITERRANEAN RIDGE SOUTH OF CRETE : SOURCES OF HIGH BACKSCATTER CONTRASTS IN SIDESCAN SONAR IMAGES

Alexander V. VOLGIN[1] and John M. WOODSIDE[2]

[1] Geology Department, Moscow State University, Vorobjevy Gory, Moscow 119899, Russia
[2] Faculty of Earth Sciences, Free University, De Boelelaan 1085, 1081 HV Amsterdam, The Netherlands

Mud domes on the Mediterranean Ridge are observed by OKEAN long–range and MAK–1M deep–towed sidescan sonar systems as patches of seafloor with higher backscatter intensity than from surrounding areas. The cause of variations in backscatter intensity are determined from an analysis of sidescan sonar sonographs, subbottom profiler records, underwater TV, and geological bottom sampling data to be the distribution and physical properties of mud breccia associated with the mud domes as well as its relationship to seabottom roughness and topography. Mud breccia inhomogeneities represented by millimetric/centimetric clasts and free gas bubbles are considered to be significant sources of volume scattering of the sidescan sonar sound signal. Detailed mapping of mud domes using different sidescan sonar systems becomes important because of differences in physical properties between individual mud domes and mud flows; but for acoustical modelling and identification of the contributions made by the different sources to the backscatter, further investigation are necessary.

Small echo–free patches have been observed in MAK–1M sidescan sonar images of a region of mud diapirs on the Mediterranean Ridge. The unusual shape of these patches and the absence of any backscattered signal from them can be more easily explained by the presence of brine pools than by topographic or sedimentological effects. From the acoustic properties of brine (high salinity and its associated relative high sound velocity and density) and its smooth horizontal surface, a brine pool reflects and refracts sidescan sonar signals at low grazing angles away from the seafloor without backscatter. The brine pools are associated with faults and collapse structures as in some other parts of the Mediterranean Ridge. The presence of brine pools in this area could mean that Messinian evaporites are present at shallow depth or accessible through fluid conduits within the upper part of the ridge, and that they may therefore be related to the development of the mud diapirs and mud volcanoes.

G

THE ACTIVE DEFORMATION OF ERATOSTHENES SEAMOUNT, SOUTH OF CYPRUS

J. M. WOODSIDE[1], M. K. IVANOV[2], R. B. KIDD[3], A. F. LIMONOV[4] and A. H. F. ROBERTSON[5]

[1] Free University, De Boelelaan 1085, 1081 HV Amsterdam, The Netherlands
[2] Moscow State University, Russia
[3] University of Wales, Cardiff, United-Kingdom
[4] Moscow State University, Russia
[5] University of Edinburgh, United-Kingdom

Eratosthenes Seamount is a slightly NNE/SSW–elongated block of about 100 km x 70 km which rises over 1200 m from the seafloor about 100 km south of Cyprus. Its origin is enigmatic but it is generally thought to be an uplifted or remnant block of the African continental margin. New seismic data clearly show the seamount to be underthrusting both Cyprus to the North and Nile sediments to the South, suggesting that Eratosthenes is buckling between the colliding African and Turkish plates. The plateau forming the top of Eratosthenes is separated into different levels by faults cutting it in a roughly WSW–ENE direction. Mass movements including large slides are evident on its flanks. The western flank appears to be thrusting beneath sediments to the West; but the eastern flank shows evidence of normal faulting with rotated blocks. There also seems to be a discontinuity between the seamount and the gently north–sloping Levantine basin to the East, suggesting faulting, possibly connected with the Southeast flank of the Hecataeus Ridge and the eastern part of the Cyprus arc to the North.

Northwards underthrusting beneath Cyprus, probably since Early Miocene, has caused and is causing strong compression in southern Cyprus with both uplift and southward thrusting; and the amplification of these forces since Late Miocene time was probably the result of wedging of the Eratosthenes block beneath Cyprus, which continues to the present. Because the gravity anomaly associated with Eratosthenes can be explained largely by the topography of the seamount (there is almost no associated Bouguer anomaly), it is postulated that the structure is caused in large part by up–arching since Early Miocene time with active tectonic modification during the current stage of breakup. Counterclockwise rotation of the entire block, occurring as part of the wedging process, has resulted in underthrusting of Eratosthenes beneath the sediments to the West, the cross–cutting WSW–ENE faulting, and some rifting between the eastern flank of Eratosthenes and the NE–SW fault zone defining the edge of the Levantine basin to the east of the seamount. It is therefore a very tectonically–active feature undergoing destruction in the collision process.

G

BENTHIC FORAMINIFERA AS INDICATORS OF POLLUTION IN THE EASTERN MEDITERRANEAN

Valentina YANKO

Institute for Nature Conservation Research, Faculty of Life Sciences, Tel Aviv University, Ramat Aviv 69978, Tel Aviv, Israel

A detailed study of foraminiferal populations was carried along the Mediterranean coast of Israel and Turkey.

The primary goal is to investigate the influence of pollution of the eastern Mediterranean marine environment upon the benthic fauna. Foraminifera were chosen to be studied in particular as a representable faunal type.

In order to carry out the primary goal many specialists from the fields of biology, botany, ecotoxicology, natural history, geology, chemistry, and oceanography were involved. Following analyses have been performed or are in progress : (1) Taxonomic and ecological analysis of benthic foraminifera, (2) Experimental ecotoxicological study of transport and defense systems of foraminifera, (3) Geochemical and morphological analyses of foraminiferal tests, (4) Isotope analysis of foraminiferal tests. Foraminiferal parameters were correlated with various oceanographic, sedimentological, geochemical and biological factors (i.e. primary productivity).

Foraminifera show a clear response to various pollution sources such as heavy metals, coal and domestic sewage (YANKO *et al.*, 1994). It supports the feasibility of studying benthic foraminifera as a technique for the *in situ* continuous monitoring of near shore marine pollution. Industrial pollution, especially by coal and heavy metals, has a deleterious effect upon the foraminifera. This is denoted by a reduced population diversity and density, stunting of the tests and increase of percentage of abnormal shells.

This suggests that the defense system of foraminifera may be damaged by xenobiotics. Experimentally a few defense mechanisms have been found and their damage by certain heavy metals (Hg, Pb and Cd) was detected (YANKO and BRESLER, 1994; BRESLER and YANKO, in press).

On the other hand, the foraminifera responded positively to the presence of domestic sewage. Apparently they accept it as a nutrient source. If this is indeed so, the inference may be drawn that benthic foraminifera may be useful not only for detecting anthropogenic pollution, but also natural organic pollution as well. Anomalously large test sizes and species abundance may potentially indicate the presence of naturally occurring organic material. Such may be the case where natural gas seepages occur in the shallow marine environment.

Therefore, the study of shallow water benthic foraminifera has a wide, as yet not completely realized, potential in a variety of fields where the monitoring of the present marine environment or analysis of the paleomarine section is required.

REFERENCE

BRESLER V. and YANKO V., 1994, Study of the eastern Mediterranean coastal environment : 2. ecotoxicology of benthic foraminifera and methods for determination of toxic action (experimental study). Six Annual Symp. on the eastern Mediterranean Continental Margin of Israel, Haifa, Abstract volume : 61-63.

BRESLER V. and YANKO V. Chemico-ecological approach to study of some benthic foraminifera. *J. Foram. Res.*, in press.

YANKO V., KRONFELD J. and FLEXER A., 1994b, Response of benthic foraminifera to various pollution sources: implications for pollution monitoring. *J. Foram. Res.*, v. 24, p. 1-17.

BENTHIC FORAMINFERA RECORD THE HOLOCENE MEDITERRANEAN - BLACK SEA CONNECTION

Valentina YANKO[1], James KENNETT[2], Hayrettin KORAL[3], Joel KRONFELD[4]

[1]Institute for Nature Conservation Research, G.S. Wise Faculty of Life Sciences
Tel Aviv University, Ramat Aviv 69978, Israel
[2] Marine Science Institute, Univ. of California, Santa Barbara, California 93106, USA
[3] Department of Geological Engineering, Istanbul University
34850 Avcilar-Istanbul, Turkey
[4] Department of Geophysics and Planetary Sciences, Tel-Aviv University, Israel

The rise in global sea level following the last glacial maximum led to connection between the eastern Mediterranean sea and the Black sea. This connection occurred over the intervening sea of Marmara, via its two shallow straits (the Dardanells and the Bosporus). Until now details on continuity and intensity of the oceanographic connections, based upon faunal migration, have not been presented. Shallow water benthic foraminifera can be used to define low amplitude fluctuations in Holocene sea levels and record the intensity of the interaction of the chemically differing water masses. Today, the salinity of the eastern Mediterranean sea is 39‰ compared with 17.5‰ for the Black sea. During earlier intervals in the Holocene these differences were even more pronounced.

The present study shows that there was a continuous oceanographic connection between the Mediterranean sea and the Black sea throughout the Holocene (last ~10 ka). A detailed synthesis of chronological, sedimentological, and foraminiferal data shows that six transgressive-regressive cycles in the Black sea (YANKO, 1990) can be correlated to cycles recorded during the past 8.44 ka in a sediment core from the sea of Marmara. During trangressions Mediterranean species are introduced into the Black sea via the sea of Marmara and the species diversity increased. At the same time the light, counterflowing, Black sea-derived upper water mass hindered oxygen regeneration in bottom waters. Oxygen deficiency during transgressions in the sea of Marmara is accompanied by an increase in infaunal forms, and an increase pyritization of the foraminiferal tests (up to 40%). On the contrast, regressions coincide with a decrease in species diversity in the sea of Marmara in sense the available oxygen in the bottom waters of the sea of Marmara (with resulting decrease in the pyritization and a decrease in the importance of infaunal species).

The most conspicuous trangressive stages occurred at 6.9 and 4.2 ka. A very strong regression is recorded at 2.6 ka. The response of benthic foraminiferal assemblages as defined in this study should be potentially useful in paleoceanographic reconstructions in the region.

REFERENCE

YANKO, V., 1990. Stratigraphy and paleogeography of marine Pleistocene and Holocene deposits of the southern seas of the USSR: *Mem. Soc. Geol. Ital.*, v. 44, p.167-187.

G

I

COMITÉ
MILIEUX INSULAIRES

Président : Bruno MASSA
Vice-Présidents : Marc CHEYLAN, Costas KRIMBAS

AN INVESTIGATION ON THE MAJOR SEWAGE OUTFALL IN MALTA

V. AXIAK and P. CHIRCOP

Marine Ecotoxicology Laboratory, Department of Biology, University of Malta, Msida, Malta

The coastal zone of densely populated island states like Malta are often threatened by environmental hazards resulting from the discharge of untreated sewage or wastewaters into the marine environment. This paper reports on the first full investigation on the major sewage outfall in Malta. This is located at Wied Ghammieq on the north eastern coast of the island (Fig. 1), where 80% (approx. 40,000 m^3 per day) of the total urban and industrial wastewater in Malta is discharged untreated through a 700 m long outfall pipe. The pipe ends in a diffuser at a depth of 36 m. In order to determine the extent and direction of the resultant sewage plume under different hydrographic conditions, several water parameters were monitored at various depths over a period of one year (1991-1992) when the submarine outfall was fully operational. Water currents were measured at various depths using drogues. The same survey was repeated more recently (June 1994) while the outfall was not functioning properly and the sewage effluents were being discharged directly from the shoreline.

Water stratification was evident during summer with a thermal step of 2.4°C being present at 25 - 30 m depth, probably leading to subsurface jet trapping at a depth where the density of the hyposaline jet is equivalent to that of the water column. The bottom plume could also be detected by reduced water temperatures at the bottom near the outfall.

When the submarine outfall was operational, water visibility near the outfall was low (e.g. Secchi depth: 1.5 m) but rapidly improved with distance away from outfall reaching background levels. Anoxic or hypoxic conditions were never evident throughout the water column. Nitrate levels were generally low, a maximum of 3.31 ug-at N/l being reported only near the outfall. Phosphates however were quite high near the outfall, the highest being 4.39 ug-at P/l, which is far above the 1.5 ug-at P/l given by HUNTER and RENDALL (1986) to be the limit above which water is considered polluted. Levels however decrease rapidly with distance to background values (0.06 ug-at P/l). N/P ratios show that the region under investigation generally exhibits optimum assimilatory proportion for the two nutrients, except for the region in the immediate vicinity of the outfall where nitrogen was limiting.

Surfactant levels were very low, the highest level being 0.076 mg/l which is below the 0.1 mg/l level expected in the vicinity of a sewage outfall (APHA 1985), and decreased with distance from the outfall. Total coliforms (TC) at surface were low, being well below the 100 CFU/100 ml limit for clean waters given by the EC. Levels in faecal coliforms (FC) in the vicinity of the outfall showed that the level of dilution of the sewage plume being achieved in the area is very high. Phytoplankton counts decreased rapidly towards the vicinity of the outfall. The species composition also varied so that *Skeletonema costatum* and other centric diatoms were the dominant forms nearest to the area under the influence of the discharge, with dinoflagellates being absent.

The mean surface current velocity near the Wied Ghammieq outfall was generally close to 0.21 m/sec. Deeper currents were slower, generally at half the surface current values, and were in most cases not directly influenced by wind direction.

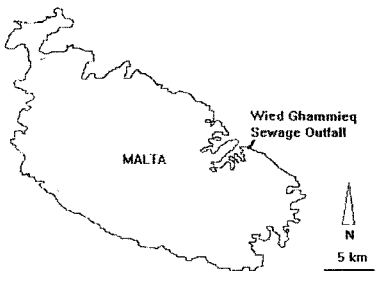
During the more recent survey, the sewage effluents were being discharged directly onshore due to a malfunctioning of the submarine outfall. A highly visible plume extended out at sea to an approximate distance of 100m. The plume was directed along the coast towards the south-east. In this case, the direction of surface sea currents was along the shore towards the SE with a mean speed of 0.31 m/sec.

The highest reported levels of TC (above 10 000 colony forming units/100 ml) were those within the plume itself at approximately 1300 m away from the discharge point. Relatively high levels of TC were also recorded along over 5 km of coastline, both at the surface and in the bottom waters. Highly contaminated waters carrying more than 1000 FC CFU/100ml extended up approximately 2 km away from the original discharge point. Such levels are above the national guidelines for bathing waters.

To conclude, the present study showed that the fast water currents as well as the design and location of the outfall should provide a very good dilution of the discharged effluents, when the submarine outfall is fully operational. However taking into account the reported levels of nutrients, water visibility and other indicator parameters, it may be estimated that during periods of onshore currents, approximately 5 km of coastline may be under the influence of this discharge. On the other hand, when the submarine outfall is not operational and the wastewaters are being discharged onshore, the microbiological contamination of the coast extends up to 5 km from the discharge point rendering the whole area unfit for bathing.

This study was a preliminary investigation to assess the geographical extent of the sewage plume discharged by this outfall. It is the first stage of a longer-term project aimed at assessing the environmental impact of local sewage outfalls and at providing the necessary background information for a master sewerage plan for the island.

Fig.1 Location of the major sewage outfall in Malta



REFERENCES

APHA., 1985. - Standard methods for the examination of water and wastewater. 16th ed., 581-585 APHA.AWWA.WPCF

HUNTER J., AND RENDALL D., 1986. - Water quality in the Inverness and Beauly Firths. *In* : Proceedings of the Royal Society of Edinburgh 91B, 315-327.

THE STATE OF *POSIDONIA OCEANICA* (L.) DELILE MEADOWS IN THE MALTESE ISLANDS (CENTRAL MEDITERRANEAN)

JosephA. BORG & Patrick J. SCHEMBRI

Department of Biology, University of Malta, Msida, Malta

We have assessed the state of local *Posidonia oceanica* meadows by considering spatial and bathymetric distribution, general health, and plant morphological characteristics. Our results show that dense and healthy meadows cover large areas of bottom off the Maltese coasts and extend to considerable depths, in places down to 43 m. At some sites where there is a strong anthropogenic influence, *Posidonia* meadows have regressed or been killed off altogether.

Data on the spatial and bathymetric distribution and on phenology of *Posidonia* meadows in the Maltese islands is lacking, even though dense beds of this seagrass cover large areas of bottom off the islands' coasts. The only information available on the spatial distribution of *Posidonia* meadows is that presented by ANDERSON *et al.* (1992) in the form of a map of the benthic communities around the Maltese Islands; DREW & JUPP (1976) give the only local data on growth and morphological parameters of this seagrass. The aim of our research is to assess the state of *Posidonia* meadows in the Maltese Islands in order to establish a baseline against which to compare future work.

The spatial extent of *Posidonia* meadows around the Maltese Islands was mapped using standard SCUBA diving techniques. Because of this, our data is limited to the depth of safe diving, in practice about 45 m (Fig. 1). Typically along the coasts of Malta, *Posidonia* first occurs as patchy stands at a depth of around 5 to 6 m and continues as dense meadows down to depths of 25 to 30 m on soft sediment. It is only in the more sheltered bays and inlets that continuous meadows are found in very shallow water (1 to 3 m). The Malta-Comino and Comino-Gozo Channels (Fig. 1) have particularly dense and healthy meadows. In March 1994, we discovered a healthy *Posidonia* meadow at a depth of 43-44 m at Wied Ternu, off the southwestern tip of Comino island. Three 0.125m^2 quadrats were used to estimate the shoot density. This varied between 125 and 155 shoots/m^2. The mean number of leaves per shoot was 4.2 (n = 10), while the mean length of the leaves (based on intermediate and adult leaves) was 14.4 cm. The leaf width was between 8.5 and 9.5 mm. We are aware of only a few records of *Posidonia* meadows growing at such depths in the Mediterranean (for example, MEINESZ *et al.*, 1988; BOUDOURESQUE *et al.*, 1990).

In other parts of Malta, such as at Mellieha Bay, frequent anchoring of pleasure boats is probably the main factor causing significant damage to the extensive *Posidonia* meadows originally present, as shown by an increase in the size and number of "intermatte" areas in the bay. Two *Posidonia* barrier reefs have been discovered in this bay, and another in the nearby Salina Bay.

In several bays and creeks where harbours are located, *Posidonia* meadows have regressed and have been totally replaced by pollution-tolerant benthic communities characteristic of such environments (for example, Marsamxett and Grand Harbour). At Pretty Bay, Birzebbuga, dumping of large amounts of sediment dredged from the seabed and pumped onshore to create an artificial beach, buried and killed most of the seagrass meadows in the area when it was subsequently moved offshore by wave action and currents (BORG & SCHEMBRI, 1993). At Mistra Bay and Mellieha Bay, offshore fish farming operations have caused regression of *Posidonia* meadows located under the fish cages.

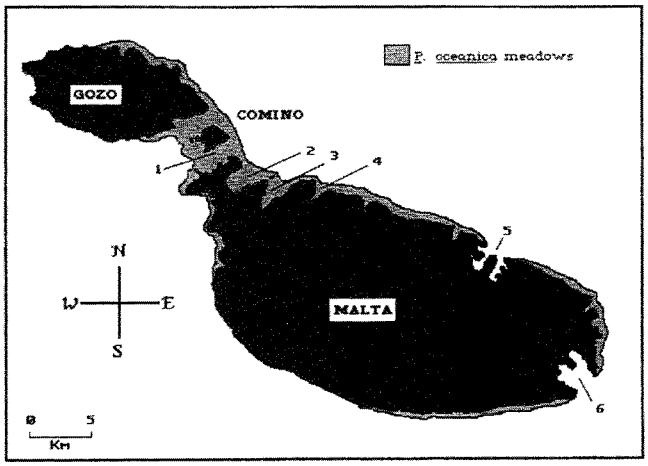


Fig. 1: Small scale map of the Maltese islands showing the spatial distribution of *P. oceanica* meadows, and localities mentioned in the text: 1 Wied Ternu, 2 Mellieha Bay, 3 Mistra Bay, 4 Salina Bay, 5 Marsamxett and Grand Harbour, 6 Pretty Bay.

REFERENCES:

ANDERSON E., ROLE A. & SCHEMBRI P. J., 1992. Coastal zone surveys of the Maltese Islands: onshore and offshore. *In:* J. L. SUAREZ DE VIVERO (ed.), The ocean change: management patterns and the environment: 139-152. Universidad de Sevilla, Seville, Spain.

BOUDOURESQUE C. F. , BIANCONI C. H. & MEINESZ A., 1990. Live *Posidonia oceanica* in a coralligenous algal bank at Sulana Bay, Corsica. *Rapp. Com. inter. Mer Medit.*, 32 (1) : 2 pp.

DREW E. A. & JUPP B. P., 1976. Some aspects of the growth of *Posidonia oceanica* in Malta. *In:* E. A. Drew, J. N. LITHGOE & J. D. WOODS (eds.) Underwater Research: 337-368. Academic Press, U.K.

BORG J. A. & SCHEMBRI P. J., 1993. Changes in marine benthic community types in a Maltese bay following beach rehabilitation works. Conference proceedings, Clean Seas Conference 1993, Valletta, Malta: 7 pp.

MEINESZ A., BOUDOURESQUE C. F., & LEFEVRE J. R., 1988. A map of the *Posidonia oceanica* beds of Marina d'Elbu (Corsica, Mediterranean). P.S.Z.N.I. *Marine Ecology*, 9 (3): 243-252.

I

CONTRIBUTION TO FAUNA CONSERVATION IN THE MEDITERRANEAN ISLANDS. THE RED LIST OF BIRDS

Pierandrea BRICHETTI[1] & Bruno MASSA[2]

[1] Centro Italiano Studi Ornitologici, Via V. Veneto 30, Verolavecchia (Brescia), Italy
[2] Istituto di Entomologia Agraria, V.le delle Scienze 13, 90128 Palermo, Italy

New criteria have been suggested to include animal species in red lists; for example BIBBY *et al.* (1989) propose the following ones for birds : 1) nesting or wintering species of international importance (if more than 20% of the population of western Europe nest or winter in the country); 2) nesting species which are rare because of the scarcity of their habitat or because they are on the edge of their distribution area (if in the country less than 300 pairs nest); 3) decreasing nesting species (with at least 50% of decrease as from the 60s); 4) nesting or wintering species confined to vulnerable habitats, with more than 50% of the population confined to about ten sites. TUCKER (1991) believe that a 20% decrease in the last twenty years is an objective risk for a species, but also their habitat vulnerability (species confined to few or small habitats or vulnerable sites) or some absolute values (less than 10.000 pairs nesting in Europe) can be useful to reckon the risk. Besides it can also be evaluated only in Europe; e.g.: some species, whose the most important populations live outside Europe, but less than 50% (and more than 5%) of the total known population lives in Europe and is in urgent need of conservation; or some species whose populations are mainly distributed in Europe that has therefore an international resposibility for them. The latter should be extended to those areas that are important for their concentration of migrant species. GRIMMET & JONES (1989) have used the following criteria to inventory the important bird areas in Europe: 1) sites of concentration for breeding, migration or wintering (with the so-called criterion of 1% of biogeographic or European population); 2) sites in which there are species threatened on a large geographic scale; 3) sites in which there are species or subspecies that are threatened only in Europe; 4) sites for species which have a small world distribution and important European populations.

Mediterranean area covers very many countries and consequently criteria for red lists must include parameters of biologic and biogeographic nature as well as distributional trend; we propose an objective method for birds which takes into consideration the following ones, weighing each of them with a value between 1 and 3 :

- a) endemism degree : endemic species = 3; subspecies very characterized and geographically restricted = 2; subspecies distributed over than one single island = 1;
- b) population insularity : 76-100% of species distribution lies in the islands = 3; 26-75% = 2; 1-25% = 1;
- c) rarity :< 100 pairs in the islands = 3; 101-500 = 2; > 500 = 1;
- d) insular distribution : apart from continental distribution, the species is present in 1-25% of the islands = 3; in 26-75% = 2; in 76-100% = 1;
- e) population trend : much decreasing = 3; decreasing = 2; stable or fluctuating = 1;
- f) distribution area trend : distribution area much decreasing = 3; decreasing = 2; stable or fluctuating = 1;
- g) extinction : if the species has become extinct in one or more islands = 3;
- h) vulnerability :sedentariness, habitat specialisation, feeding specialisation, threatened from human presence, impossible to reintroduce when become extinct = 1 for each parameter.

In accordance with the sum of these figures calculated for the 99 bird species living in the Mediterranean islands, we put them in order of increasing threat.

I

REFERENCES

BIBBY C., HOUSDEN S., PORTER R. & THOMAS G., 1989. Towards a bird conservation strategy. *RSPB Conservation Review*, 3: 4-8.

GRIMMETT R.F.A. & JONES T.A., 1989. Important Bird Areas in Europe. *ICBP Techn.Publ.*, 9, Cambridge.

TUCKER G., 1991. The ICBP Dispersed Species project, a new initiative for bird conservation in Europe. *Bird Census News*, 4 (1): 13-18.

COASTAL CONSERVATION PROBLEMS : PROTECTION OF WASTEWATER TREATMENT PLANTS FROM TOXIC INDUSTRIAL EFFLUENTS

G. CASSAR[1], V. AXIAK[1] and V. GAUCI[2].

[1] Marine Ecotoxicology Laboratory, Depart. of Biology, Univ. of Malta, Msida, Malta
[2] Department for Environmental Protection, Ministry of Environment, Floriana, Malta

Limited freshwater resources as well as densely populated coastlines which have to be protected from the discharge of untreated sewage and wastewaters have led to the widespread use of wastewater treatment plants in many islands in the Mediterranean. Nonetheless the efficiency of such wastewater treatment plants depends very much on the quality of effluents they have to act upon. Certain stages in the bio-treatment processes such as nitrification are quite sensitive to toxic industrial effluents. Nitrification, or the conversion of ammonia to nitrate by autotrophic microbial activity, is essential in the treatment of wastewaters for a number of reasons, namely :

a) nitrification prevents the discharge to receiving waters of ammonia. This is toxic to fish at concentrations as low as 0.5 mg l^{-1}, especially at high pH conditions.
b) nitrification in the receiving water exerts a significant oxygen demand and thus can deplete the dissolved oxygen resources of the surface waters
c) nitrification can have also financial implications where disinfection at the sewage treatment works is achieved by maintaining a trace of free chlorine in the final effluent. In the presence of high concentration of NH_3, the chlorine dose required to reach breakpoint chlorination would be several times the NH_3 concentration and thus would be prohibitively expensive.

The above reasons have led to an increasing tendency towards the requirement of some degree of nitrification at sewage treatment works. However nitrification is an extremely sensitive process which is influenced by factors such as dissolved oxygen concentration, pH and temperature. The engineer has control over these factors. In contrast , the engineer does not have control over the presence of toxic compounds in the sewage that may inhibit the nitrification process. In fact a wide variety of organic and inorganic compounds that inhibit nitrification are present in industrial wastewaters.

In Malta, presently all industrial wastewaters are discharged into the municipal sewer system. No analytical information as regards the quantity and the quality of industrial wastewaters generated by industries in Malta is available. The only indication regarding the nature of the effluents can be inferred by consideration of their activities and the products manufactured. In this respect, the scope of this work was to investigate a biological assessment method to assess the degree of inhibition to nitrification by industrial wastewaters, and thus to determine whether a particular industrial wastewater can be discharged to sewage treatment works, so as to protect the treatment plant from upsets and reduced nitrification rates.

The potential nitrifying ability of the activated sludge sampled from the Sant Antnin Wastewater Treatment Plant was assessed by centrifuging, washing and recentrifuging the sludge to remove any oxidized nitrogen and any inhibiting toxins. The sludge was mixed with a standard medium containing an excess of ammonium salts at pH 7.4 and the mixture was incubated with adequate aeration for four hours. The specific rate of nitrification was then calculated from the concentration of suspended solids and the decrease in the concentration of ammonia. This was carried out routinely in order to assess the variability in the nitrification performance which is to be expected within treatment plants even under optimal working conditions.

The degree of inhibition of nitrification by industrial wastewaters was calculated by assessing the decrease in concentration of ammonia nitrogen after parallel aeration of a nitrifying sludge obtained from Sant Antnin Sewage Treatment Plant, in the presence of different dilutions or absence of the particular industrial effluent. Effluents from three types of local industries were sampled on various days throughout 1992 and investigated. These were a tannery, galvanising and electroplating complexes. Effect on nitrification was expressed as that dilution of effluent which causes a 25% reduction in nitrification (25% Effective Concentration: EC25).

Effluents from the galvanizing factory failed to exhibit significant reduction in nitrification. On the other hand, effluents from the tannery showed an EC50 of 0.28 ml per 100 ml. This dilution factor is approximately equal to that found at the sewers. This implies that a 25% reduction in nitrification performance would be expected at the treatment plant if such effluents reach it at this dilution.

The biological test investigated has several advantages that favour the adoption of this protocol as a screening method for the discharge of industrial effluents in the sewerage system.

Standards for effluent quality should continue to be directed towards the regulation of the amount of toxicant and physical changes. However, a biological test procedure such as the one investigated, should also be carried out. Even if the effluent conforms to all limitations imposed by present standards for discharge of toxic materials, there is a high probability that a number of deleterious effects will result on the sewage treatment works from both synergistic actions and enhancement of toxic effects. Effective protection of the coastal environment often depends on the efficient operation of wastewater plants. The use of this biological test for effluent quality may help ensure such desired efficiency.

FACTEURS D'ÉTABLISSEMENT ET D'ÉVOLUTION DES PAYSAGES DANS UNE RÉGION DE MONTAGNE INSULAIRE LA VALLÉE DU GOLO, ZONE PILOTE DU PROGRAMME MEDIMONT EN CORSE

Yves CONVENTI

Parc Naturel Régional de Corse - Université de Corse. 20250 Riventosa, France

La présente recherche s'inscrit dans le cadre du programme MEDIMONT, qui étudie la diversité des phénomènes de désertification en milieu méditerranéen et montagneux (CONVENTI, 1993). En Corse, sur une zone pilote - la vallée du Golo - de 1000 km^2, l'évolution contrastée des paysages est analysée qualitativement et en terme fonctionnel, en relation avec les variables mésologiques (Tab. 1).

Tab. 1 - Occupation des sols : matrice de transition pour la période 1770 / 1992 (en hectares)

	TLA	TMK	TFO	TCH	TRR	TRV	**Total 1992**
Rypisylve	116	124	9	82	0	1	332
Groupt à Quercus pubescens	1 819	1 693	136	795	1	24	4 468
G. à Castanea sativa	1 420	579	85	633	12	36	2 765
G. à Fagus sylvatica	56	63	113	16	0	2	250
G. à Alnus suaveolens	52	876	1 064	0	254	2 025	4 271
G. à Arbutus unedo	1 836	2 345	333	309	14	256	5 093
G. à Quercus ilex	3 598	4 268	841	700	18	188	9 613
G. à Pistaccia l. et Olea e.	6 701	5 277	410	628	33	590	13 639
G. à Erica arborea (supramed.)	952	819	941	0	41	368	3 121
G. à Pinus maritima	582	962	281	70	2	173	2 070
G. dense à Pinus laricio	178	379	2 141	0	5	710	3 413
G. lâche à Pinus laricio et Erica a.	383	695	1 520	0	32	1 020	3 650
Fruticée à Cistus sp. Calycotome	3 427	3 222	269	125	82	608	7 733
Frut. à Prunus spinosa, Rubus sp.	919	280	62	2	84	88	1 435
Frut. à Helichrysum italicum	2 324	1 836	185	104	51	198	4 698
Frut. à Berberis, Juniper., Genista	1 065	1 755	664	2	258	445	4 189
Fruticées rases et rochers	1 210	1 992	284	77	30	157	3 750
Pelouses	1 896	456	74	124	3	46	2 599
Sol nu	1 053	5 034	1 925	93	1 608	5 105	14 818
Total 1770	29 587	32 655	11 337	3 760	2 528	12 040	91 907

TLA : terres labourées, TMK : maquis, TFO : forêts, TCH : chataîgneraies, TRR : rochers, TRV : mélange maquis/rochers

Cette évolution contradictoire résulte du fait qu'après une longue période durant laquelle les hommes ont modelé et structuré les paysages de la Corse, la diminution soudaine de la population rurale a induit une destructuration de l'espace insulaire (DYKSTRA, 1993).

Dans ce contexte d'abandon et de désert humain, l'action combinée du feu, du surpâturage, de la sécheresse estivale et des fortes précipitations produit, sur les fortes pentes de l'île, des phénomènes de dénudation et de perte de biomasse qui conduisent à la réduction difficilement réversible des ressources nécessaires à la vie. Malgré le contexte bioclimatique relativement humide de la région étudiée, ces phénomènes sont identifiés comme des facteurs de désertification potentielle. A l'opposé, certains terrains connaissent une remontée biologique spectaculaire, en particulier avec le développement du chêne pubescent, sur les anciennes terrasses de culture autour des villages de la vallée.

La comparaison de ces deux modèles d'évolution est facilitée par l'utilisation d'un système d'information géographique qui intègre les données relatives à l'occupation des sols au XVIIIe siècle, la répartition actuelle de 34 groupements végétaux obtenue par classification d'image satellite, et différents paramètres mésologiques liés au climat (précipitation, bioclimat), au substrat (sol, texture, profondeur) ou à la topographie (altitude, pente, exposition) (KIENAST, 1993). La base de données ainsi réalisée inclut aussi l'historique des incendies sur les 24 dernières années ce qui représente environ 1000 feux et 25 000 hectares brûlés.

Le croisement des différents thèmes successivement étudiés, en relation avec l'étude des tendances démographiques, permet d'une part de comprendre les modes d'utilisation des ressources du territoire et leur impact sur l'évolution des paysages, d'autre part de hiérarchiser l'importance des facteurs mésologiques en interaction les uns avec les autres.

REFERENCES

CONVENTI Y., 1993. Désertification potentielle, évolution de la mosaïque des paysages en Corse. Rapport préliminaire Medimont (non publié)

DYKSTRA G., 1993. Usage des sols et démographie. Compte rendu de recherche, Doc. Parc Naturel Régional de Corse, Riventosa, 14 p.

KIENAST F., 1993. Analysis of historical patterns with a geographical information system - a methodological outline, Landscape ecology, vol. 8, pp. 103 - 118.

EFFETS DU FEU SUR LA MICRO ET MÉSOFAUNE DU SOL

M. A. DE MIRANDA RESTIVO, L. DURANTE, M. MAXIA, E. SERRA

Dipartimento di biologia animale e di ecologia, Università di Cagliari, Italia

Nous disposons de nombreuses données sur les effets du feu dans la région méditerranéenne pour les aspects microclimatiques, pédologiques, botaniques et avifaunistiques mais en ce qui concerne les conséquences dans la micro- et la mesobiota les données manquent. Le présent travail vise à déterminer les variations de densité, de richesse en taxa et les biomasses des peuplements de l'euédaphon et de l'hémiédaphon, dans des zones bien définies de la forêt de Monti Mannu (Sardaigne méridionale). Ces zones ont subi des incendies à diverses périodes et avec des intensités très différentes. Nous avons aussi étudié l'hydrobiote de l'euédaphon. Les échantillonnages ont été effectués chaque mois pendant une année. La terre et la litière ont été échantillonnées selon les techniques courantes (LEWIS T., TAYLOR L.R.)

La station 1 n'a pas subi d'incendies depuis plusieurs années, c'est un bois épais dont la végétation se compose de *Quercus ilex, Pistacia lentiscus, Phyllirea angustifolia.*

La station 2 située sur le versant Sud a subi son dernier incendie en 1976; on n'y trouve que du *Cistus.*

A la station 3, le dernier incendie remonte à 1980; des précipitations torrentielles ont entraîné une dégradation ultérieure du terrain. Sa végétation est une lande de *Cistus* et de *Quercus suber.*

La station 3B. a subi les effets des incendies en 1983; ici aussi il y a une reprise de la végétation composée de *Cistus* et de quelques chênes-lièges.

Station 4 : ici le dernier incendie remonte à 1980. Nous avons constaté une reprise bien vigoureuse de la végétation : *P. lentiscus, Q. suber, Cistus sp.*

La station 5. a subi les effets de l'incendie de 1983 de façon plus accentué que la station 3. La végétation ici se présente comme une lande de cistes et d'asphodèles; la couche de la litière y est absente.

Nos données montrent que l'hémiédaphon est plus riche, en terme de densité de peuplements ou en terme de richesse en taxa, que l'euédaphon. Les taxa retrouvés sont : Aracnida, Insecta, Myriapoda, Diplopoda, Crustacea, Nematoda, Gastropoda, Oligochaeta. Le taxon le plus fréquent est représenté par les Acarina suivi par Collembola. On peut enregistrer, pour ce qui concerne la densité, une reprise dans les stations incendiées selon l'ordre suivant: 3B>2>4>3>5. La station 3B, pourtant incendiée récemment, a une plus grande densité que la station 2.

En ce qui concerne la richesse en taxa, le plus grand nombre a été relevé dans les stations 1 et 2, avec 14 unités systématiques pour l'hémiédaphon et 10 à12 pour l'euédaphon. Dans les stations récemment incendiées, la diversité en espèces est inférieure.

Nous pouvons donc conclure qu'il faut attendre au moins 10 à 15 ans pour assister au renouvellement des conditions du milieu.

	Station jamais incendiée	1976	1980	1983
Acarina	*	*	*	*
Pseudoscorpiones	*	*	*	*
Araneae	*	*	*	*
Collembola	*	*	*	*
Protura	*	*		
Hymenoptera	*	*	*	*
Coleoptera	*	*	*	*
Thysanoptera	*		*	*
Embioptera	*	*	*	
Rhincota	*	*	*	*
Corrodentia	*	*		
Blattoidea	*	*		
Diplura	*	*		
Orthoptera	*	*	*	
Diptera	*	*	*	*
TOTAL TAXA	**15**	**14**	**11**	**9**

La microbiota aquatique comprend les taxa suivants : Diatoma, Rotifera, Protozoa, Nematoda. Malgré les effets dévastateurs du feu, nous avons remarqué dans toutes les stations incendiées une lente reprise de la microbiota.

REFERENCES

ALICATA P., ARCIDIACANO R., CARUSO D., MARALLISO I., 1972- Distibuzione dei Microartropodi del suolo della lecceta di Castelporziano. Roma.- *Boll. Acc. Gioenia Sc. Nat.*, Catania, 11 (3-4).

ARCARA P.G., BURESTI E., SULLI N., SULLI. A, ZANZI A., PIUSSI P., 1976- Risultati di alcune indagini sugli incendi boschivi. Atti del colloquio C.N.R. 20-5-76, Roma.

MOTTA S. & PETRALIA A. 1977- Fluttuazioni stagionali della densità e della distribuzione dei microartropodi edafici (acari e collemboli) nella lecceta di Monte Minardo (Etna) - *Boll. Acc. Gioenia Sc. Nat.*, Catania, 3-4.

I

PRESENTATION OF THE MEDIMONT PROJECT ON DESERTIFICATION AND THE MEDITERRANEAN MOUNTAINS

Michel DUBOST

ICALPE, 20250 Riventosa-Corte (Corsica), France

Mountainous areas are characterised by a delicate balance between ecosystems productivity and human use of natural resource. Many critical developments can be observed all over the world which endanger this delicate balance (B.A.H.C., 1994).

This is particularly true in many mountain regions of the developing countries like the Himalayas, the Andes or the African ranges, where the growing demographic pressure initiates vicious circles of degradation. Serious problems concern also mountain areas in developed countries. Deforestation, wildfires, erosion, agriculture decline, air pollution, massive tourism, traffic, etc. are but a few examples which affect soil, vegetation, water and other vital resource of mountainous areas in a critical way.

Everywhere, mountain environments are also among the most sensitive to a possible climate change.

The Mediterranean area is a good example of such critical developments. In the North and the South anthropogenic activity is responsible for massive degradation. Maintaining the capacity of mountains as water towers and primary water sources is for instance a major concern to avoid further reduction of water availability, which is a threat to many countries (MARGAT J., 1992). Thus, addressing the role of mountainous areas in the desertification process around the Mediterranean basin is a key issue for this region.

The study of desertification phenomenons requires the combination of various sources of information at different time and space scale-levels (DUBOST M., 1994).

MEDIMONT is an example of such studies. Coordinated by ICALPE and selected for support by the EC DG XII, it assembles many teams from Spain, France, Italy and Greece.

It is a multidisciplinary research and development programme on the role and the place of the mountains in the desertification process of the Mediterranean regions.

The main objectives are to understand the desertification process in the Mediterranean mountains, under various natural and human conditions, and deliver guidelines for a rational management of such areas, including prevention, monitoring and appropriate policies for sustainable development.

The project is a combination of local-scale and regional-scale investigations.

Regional-scale approaches consist in a series of parallel investigations ranging from sensitivity studies to climate change, through the use of remote sensing techniques and macro-economic scenarios, to historical botanical reviews.

At the local-scale, a series of case studies is carried out in pilot-zones in Greece, Italy, France, Spain, in order to study the phenomenon, identify criteria, develop guidelines at a local-scale, but also give evidence of the diversity, the similarities and dissimilarities among the study areas.

Mountainous pilot-zones have been selected in five Mediterranean regions undergoing a severe desertification process, in Andalucia, Corsica, Basilicate, Calabria, and Crete (Fig. 1).

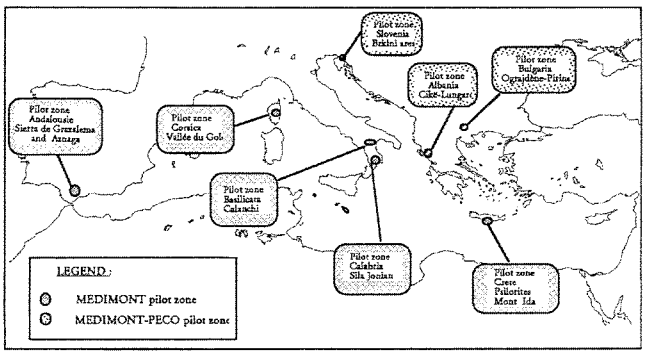


Fig. 1. Map of pilot zones of the MEDIMONT Porject and its extension to the Eastern Europe countries (MEDIMONT PECO).

Studies carried out in insular conditions within the MEDIMONT project, in Corsica and Crete, are presented in this meeting.

REFERENCES

B.A.H.C., 1994. Climate-Hydrology-Ecosystems Interrelations in Mountainous Regions (CHESMO), An International Initiative for Integrative Research. IGBP - BAHC / UNEP Workshop, Report n°2, St Moritz, Switzerland, December 1993.

DUBOST M., 1994. Desertification of Mediterranean and mountainous regions, state of art and introduction to the session "regional environmental change : desertification of mediterranean and mountainous regions, modelling and monitoring", proceedings (under press) of the14th international conference "data and knowledge in a changing world", ICSU - CODATA, Chambéry (France)

MARGAT J., 1992, "L'eau dans le Bassin Méditerranéen - Situation et Prospective", *in* Les fascicules du Plan Bleu, Ed. Economica.

LA VALEUR ÉCOLOGIQUE DE PORTO, DU SUD-EST ET DE L'EST DE L'ÎLE DE TINOS (MER ÉGÉE CENTRALE)

Nikolaos A. KYRTATOS

Centre de Recherches Marines et Côtières, Tinos, Grèce et Institut für Meereskunde, Kiel, Allemagne

Pour obtenir une protection de la nature du sud-est et de l'est de l'île de Tinos, l'espace menacé de la région côtière de Porto inclus, la valeur écologique du site a été identifiée en utilisant divers critères, donnés par des spécialistes et appliqués sur la base d'informations tant bibliographiques (BERNDT R., HECKENROTH H. & WINKEL W., 1978; COUNCIL OF EUROPE 1982; ET. AN. AL. 1977-1981; GRIMMET R. F. A. & JONES T. A. 1989; KARANDINOS M; MEBS T. 1989; PAPAKONSTANTINOU C. 1988) que récoltées par nous (KYRTATOS N. 1992 et recherches récentes) sur Porto (surface 3 km^2), le sud-est de Tinos (10 km^2), l'est de Tinos (50 km^2) et la côte est de Tinos (longueur 15 km).

1. Critères du PNUE et de la résolution (76)17 du Conseil de l'Europe

- 1.1 Dépendance de diverses espèces de la région. Au moins 104 espèces (11 plantes, 5 mollusques marins, 4 crustacés marins, 3 insectes et 81 vertébrés) dépendent de Porto ou du SE/E de Tinos pour survivre à Tinos. Il s'agit de 63 espèces menacées, 59 espèces protégées par la loi, 69 avec des populations remarquables dans la région et 4 endémiques. Pour 58 espèces, le sud-est et l'est de Tinos constituent un site d'importance pour les îles Cyclades; pour 15 espèces au moins, un site d'importance nationale et pour les phoques moines un site d'importance internationale. Parmi les 104 espèces, 95 habitent des milieux humides, 27 les marais, 10 les plages sableuses, 10 ont besoin des *Posidonia* vivants ou de leurs débris, 77 sont favorisées par une haute productivité, 25 par l'existence de grands essaims de poissons.
- 1.2 Ecosystème unique. Les rares sources de l'eau constituent un écosystème unique pour Tinos de même que les dunes, les tourbières, les eaux stagnantes, les transitions des dunes et des milieux humides vers plusieurs autres paysages naturels constituent un écosystème unique pour les Cyclades. Constituent également un écosystème unique les prairies productives de *Posidonia*, les agrégations de leurs feuilles mortes sur la côte et le fond d'Agios Ioannis au moins pour les mers grecques, et les prairies xériques et les falaises avec leurs endémiques, au niveau international.
- 1.3 Flore et faune typique. La faune et flore du site sont très caractéristiques des écosystèmes des Cyclades; la faune marine est caractéristique de la Méditerranée, si on considère qu'on retrouve la plupart des groupes bien connus (surtout les vertébrés) au petit Porto ou dans la mer au SE de Tinos. Il y a aussi des séries complètes de biocoénoses.
- 1.4 Etat naturel. Les habitats sont dans un état naturel ou semi-naturel. Dans l'est et le sud-est de Tinos, le terrain est occupé surtout par des phryganas (maquis +prairies sèches); il est traversé par 25 ruisseaux. La région de Porto est composée de mer (21%), de phrygana (58%), d'oliviers (1%), de dunes (2%), de roches et falaises (1,5%), de ruisseaux (2,5%), de marais (8%) et de prairies humides (6%). Les 2 derniers occupent la seule plaine non cultivée de l'île. La partie de Porto déclarée "zone urbaine" était composée en 1988 à 60% de phrygana, 22% de marais, 11% de prairies humides, 4,5% de ruisseaux, 1,5% de dunes et 0,5% de roche. De 1988 à 1994 s'y sont ajoutés 2% de bâtiments et 2% de gravois.
- 1.5 Diversité. Nous avons identifié 70 types d'écotopes (type d'unités du paysage, constitué par une biocoénose et son biotope), presque tous aussi à Porto, des dizaines d'écotones et un nombre maximal de vertébrés pour les Cyclades : 390 vertébrés (Porto 354/3km^2), 18 Chonrichthyes, 155 Osteichthyes, 2 Amphibia, 17 Reptilia, 185 oiseaux, 16 mammifères.
- 1.6 Productivité. Le marais, les prairies à *Posidonia* et le fond d'Agios Ioannis ont une productivité relativement haute.
- 1.7 Existence d'écosystèmes en danger. Sont en danger les eaux basses, les marais et les écosystèmes de la recommandation 92/43/CE.

2. Recommandation 92/43/CE

L'annexe I comprend 34 écotopes du site (dont 29 se retrouvent à Porto et 5 lui sont propres) et 5 écotopes de préférence, dont : les eaux stagnantes, importantes pour les Cyclades et les prairies à *Posidonia*, importantes pour la Grèce et la Communauté européenne. L'annexe II contient 9 espèces (dont 8 à Porto) et 2 espèces de préférence. *Testudo marginata et C. caretta* dépendent de Porto pour survivre aux Cyclades; 2% de la population mondiale et 4% de la population grecque de *M. monachus* vivent à Porto et à l'Est de Tinos.

3. Catalogue SFF3/CE

57 espèces d'oiseaux (4 menacées au niveau mondial et 32 menacées en Europe, 24 nicheurs) fournissent au total 10 des critères suffisants pour inclure les régions en question au catalogue SFF3 des sites d'importance avifaunistique.

4. Critères de GRIMMET et JONES

Les 7 critères sont remplis par 36 espèces d'oiseaux (13 nicheurs), soit pour Porto, soit pour de plus grandes surfaces.

5. Critères de BERNDT *et al.*, 1978

En prenant en considération 16 espèces nicheuses menacées, on constate l'importance pour la CE et la Grèce de Porto et du SE de Tinos en ce qui concerne l'avifaune, des côtes E/SE de Porto en ce qui concerne les oiseaux marins et de l'est de Tinos pour les rapaces.

6. Recommandation 85/337 de la CE et lois 1650/86 & 69269/5387/90

L'Etat doit protéger l'ensemble de la région et créer des aires strictement protégées comprenant les écosystèmes sensibles (tourbières, dunes, prairies sous-marines, falaises, côtes, ruisseaux) et les écotopes des espèces menacées (marais, écotones d'Apokofto). On doit subventionner la protection, contrôler les destructeurs de la nature et éliminer les causes de la dégradation que sont l'urbanisation, les subventions à la construction de bâtiments et leurs conséquences telles que lumières artificielles, gravois, assèchement des milieux humides, eaux d'égouts qui ont entraîné la destruction du *Cystoseiretum*, l'introduction des Tamarix sur les dunes et dans le marais, la récente construction de lignes à haute tension.

RÉFÉRENCES:

BERNDT R., HECKENROTH H. & WINKEL W., 1978. Zur Bewertung von Vogelbrutgebieten. Vogelwelt : 222-226.

COUNCIL OF EUROPE 1982. List of Rare, Threatened and Endemic Plants in Europe.

ET. AN. AL. 1977-1981. Embarquements de la pêche. Inédit.

GRIMMET R. F. A. & JONES T. A. 1989. ICBP Techn. Publ. 9: 271-307.

KARANDINOS M., ed. 1992. The Red Data Book of Threatened Vertebrates of Greece.

KYRTATOS N. 1992. Données complémentaires sur l'espace menacé de Porto. 30 p.

MEBS T. 1989. Greifvögel Europas. Franckh, Stuttgart.

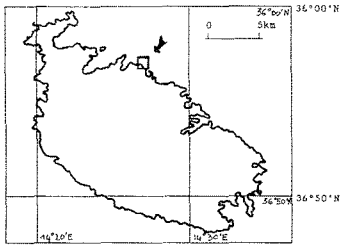
PAPAKONSTANTINOU C. 1988. Check List of Marine Fishes of Greece. Hell. Zool. Society.

GHADIRA S-SAFRA (MALTA) : A THREATENED COASTAL WETLAND WITH AN ENDANGERED BIOTA

S. LANFRANCO & P.J. SCHEMBRI

Department of Biology, University of Malta, Msida, Malta

Saline marshlands are very scarce in the Maltese Islands (SCHEMBRI *et al.*, 1987; ANDERSON & SCHEMBRI, 1989). Several have been obliterated by human activity and only five such sites are still extant, although under constant threat (SCHEMBRI & LANFRANCO, 1993). The environment of such habitats restricts colonisation to a highly specialised flora and fauna. Although many species are common to all marshlands in the Maltese Islands, each site has its own habitat characteristics and species assemblage (SCHEMBRI, 1991). The present study evaluates the ecological significance of a representative marshland and highlights the anthropogenic pressures to which it is subjected. Ghadira s-Safra is a seasonally flooded marshland of area 0.8 ha, and generally located less than 1 m above mean sea level on the northeastern coast of Malta, in the Maghtab-Ghallis area (Fig.1). The site outcrops on the Xlendi Member of the Lower Coralline Limestone Bed which is of Oligocene age. The substratum consists of a fine reddish soil underlain by a thin layer of alluvial clay which enables the marsh to retain water. In most years, the marsh contains water during the wet season (September/October to March/April) and is completely desiccated throughout summer. During the course of a typical wet season, Ghadira s-Safra undergoes several cycles of alternate wetting and drying since the large surface area and shallow depth of the water promote high rates of evapotranspiration which are sufficient to cause drying between successive flooding episodes. The marsh supports a biota of mixed character. The permanent community mainly comprises terrestrial halophilic macrophytes while the temporary community is typical of ephemeral fresh and brackish water habitats and is only present when the marsh contains water. A number of species inhabiting the marsh are of local or regional ecological significance :



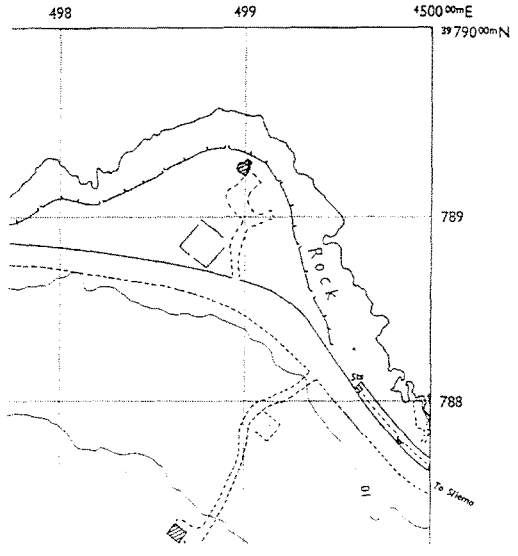
Island of Malta indicating location of Ghadira s-Safra

- 1. *Triops cancriformis* (Bosc), (Crustacea: Branchiopoda: Notostraca). Ghadira s-Safra is one of the few localities where this locally rare species has been recorded in recent years.
- 2. *Branchipus visnyai* Kertesz, (Crustacea: Branchiopoda: Anostraca). Ghadira s-Safra is the only locality in Malta where this species has been recorded.
- 3. *Crypsis aculeata* (Tracheophyta: Magnoliopsida: Poaceae). Restricted to Ghadira s-Safra.
- 4. *Riella helicophylla* (Bryophyta: Hepaticae); a very rare and endangered liverwort. Listed in Appendix 1 of the Berne Convention as a "Species to be Strictly Protected".

Additionally, an unrecorded epizoic association involving *Branchipus schaefferi* Fischer (Anostraca) and *Lyngbya* sp. (Cyanobacteria) has been observed at Ghadira s-Safra.

The marsh is subject to regular and severe anthropogenic disturbance. The site is easily accessible and is a popular recreational area with holidaymakers. Encroachment by vehicles is frequent and results in regular disruption of the upper layers of sediment. This favours the proliferation of weed species in preference to slower-growing specialists and may also damage the resting stages of organisms present during the aquatic phase. Frequent bonfires contribute to such disturbance. Although the species assemblage present would qualify Ghadira s-Safra for strict protection under current environmental and planning legislation, no concrete measures for its conservation have as yet been taken.

Vicinity of Ghadira s-Safra (side of square = 100 m)



REFERENCES

ANDERSON E.W. and SCHEMBRI P.J., 1989. Coastal zone survey of the Maltese Islands report. Beltissebh: Planning Services Division, Works Department; xii + 121pp. + maps.

SCHEMBRI, P.J., 1991. Report of survey: natural resources [Malta Structure Plan Technical Report 5.4] Beltissebh, Malta: Colin Buchanan and Partners/Generale Progetti SpA/Planning Services Division, Government of Malta; viii + 138pp.

SCHEMBRI P.J. and LANFRANCO E., 1993. Development and the natural environment in the Maltese Islands. In: Lockhart, D.G.; Drakakis-Smith, D. & Schembri, J. [eds.] The development process in small island states. pp.247-266; London & New York; Routledge

SCHEMBRI P.J., LANFRANCO E., FARRUGIA P., SCHEMBRI S. and SULTANA J., 1987. Localities with conservation value in the Maltese Islands. Beltissebh: Environment Division, Ministry of Education; iii + 27pp.

FLORA RICHNESS AND ENDEMISM IN CROATIAN ADRIATIC ISLANDS

A.Z. LOVRIC & O. ANTONIC,

Ruder Boskovic Institute, Zagreb, 41001 Croatia

Besides the Greek islands, Croatian Archipelago in Dalmatia and Kvarner Gulf of Adriatic is the most dissected one by Mediterranean and European coasts. It has 1233 islands and islets covering together 4380 km^2 i.e. 98% of all Adriatic islands, the rest being some minute islets by eastern Italy, Yugoslav Montenegro and Albania. Among them 413 are low skerry reefs without plants or with some halophytes only. The total island flora of this archipelago includes more than 2700 taxa. So far one studied the vascular floras in nearly 300 islands, and in 45 islands the floral lists are well completed and treated in actual analysis. The richest floras grow in the largest Krk (1473 taxa) and Hvar (1163 taxa), and the prospected minute reefs included 2-45 taxa.

Following the Linear Correlation analysis of vascular floras and physical geographic parameters in studied islands (cf. table), the next partial correlations emerged. Vascular floral richness is significantly correlated with the island peak heights (R = 0.82), with the island area sizes (R = 0.80) and with the area/island length ratio (R = 0.85). The logistic (asymptotical) model could be better than linear model in the cases of island area and area/length ratio as independent variables, and it will be tested on a larger sample. There is no correlation with main sea depths, mainland distances and geographical latitudes.

The Multiple Correlation Analysis, including the vascular floras richness as dependent variable and main sea depth, island height, island area, area/length ratio, mainland distances and northward latitudes as independent variables, gave R = 0.88 with the island height and area/length ratio as the significant estimators.

After the similar analyses of the vascular endemism in the same islands, it presented no significant correlations with any of these physical parameters. Croatian Archipelago includes 68 exclusive insular endemics, but they are concentrated in 28 islands and chiefly in 3 local groups of the Senj, Vis and Elafiti archipelagoes. The most i.e. 17 endemics occur in the Prvic island, some also in Vis, Krk, Jabuka, Palagruza, Goli, Jakljan, etc. It is remarkable there are only few local stenoendemics of one island, mostly in Prvic and Jabuka, being the neoendemics from the postglacial island submersion and subsequent speciation. The most of other insular endemics are the island group endemics of main island and adjacent islets or of linear islands series. They may be treated as the earlier mountain paleoendemics in Tertiary Adriatic plate, by the submersion then transformed into this archipelago with its endemics. The additional 129 subendemics of Croatian Archipelago, with their isolated sites also in Istra and Gargano peninsulas or in other minor promontories but absent elsewhere landwards, confirm the hypothesis of preinsular evolution of many Adriatic endemics. Thus the paleogeographical and paleoclimatic processes may be more decisive in these endemics, than the actual Adriatic geography.

ISLAND	A	B	D	E
Cres	903	0	648	404
Unije	596	0	138	37
Losinj	938	0	589	75
Plavnik	279	0	194	9
Kormat	29	0	6	1
Galun	45	0	10	0.4
Biskup	31	1	21	0.1
Krk	1473	6	569	410
St. Marko	169	1	102	1
St. Marin	35	0	7	0.1
Zec	24	1	13	0.2
Lisac	67	2	26	0.1
Prvic	351	17	363	15
Goli	308	4	226	5
St. Grgur	198	1	231	7
Rab	782	1	408	91
Pag	651	0	348	285
Silba	232	1	80	15
Molat	444	0	142	23
Dugi	605	1	338	114
Kornat	303	2	235	33
Drivenik	410	0	177	15
Solta	299	0	237	52
Brac	773	1	778	359
Hvar	1163	0	626	299
Jabuka	36	5	117	0.1
Svetac	419	4	305	4
Brusnik	38	1	43	0.1
Bisevo	398	1	240	6
Vis	535	6	587	90
Palagruza	245	5	105	1
Susac	255	1	243	4
Kopiste	127	0	93	1
Lastovo	737	0	417	47
Korcula	978	0	568	276
Mljet	667	0	514	101
Peljesac	862	1	963	348
Olipa	44	1	211	2
Jakljan	148	4	225	5
Sipan	618	3	243	16
Lopud	560	3	226	5
Kolocep	488	2	125	3
Lokrum	400	1	91	1
Mrkan	179	1	46	1
Bobara	86	1	45	0.3

The sample of Adriatic islands and correlations with geographical parameters.
Legend :
A = vascular flora (24-1473 sp)
B = endemism (0-17 sp)
D = main peak (6-963 m)
E = island area (0,1-410 sqkm)

I

ANIMAL SPECIES THREATENED IN THE MEDITERRANEAN ISLANDS : A PROJECT TO PRESERVE VULNERABLE HABITATS

Bruno MASSA

Istituto di Entomologia Agraria, Viale delle Scienze 13, 90128 Palermo, Italy

Mediterranean islands in the last years are facing a serious threat for coastland conservation: the widespreading of tourism industry. Following the World Travel and Tourism Council (1992), tourism today has become the most important civil industry in the world : in 1993 it was expected to generate about 3.5 trillions of dollars of world output, that is 6% of the world gross national product, and to double by the year 2005. Tourism is a bigger industry than the auto, steel, electronics or agricultural industries; it grew by more than 57% in the past decade and is expected to grow by 50% before 2000. Some mediterranean islands (e.g. Crete, Rhodes, Cyprus, etc.) in the spring-summer period (May-September) hold almost 10 millions of international travellers, with understandable consequences for the coastline and beach conservation; true, the new economy has given impetus to the agriculture and has generally changed the life style of many people who live in the coast villages, but at the same time has worsened the status of animal and vegetal coenoses through the excessive removal of natural biotopes along coastlines, the building of tourist harbours, the progressive settling of breakwaters, the beach replenishement and the pollution of coasts, which interfere with coastal currents, natural sand sedimentation, as well as terrestrial zoocoenoses and phytocoenoses.

It is necessary to plan a general project to identify the most important naturalistic areas along island coasts and to prepare an agreement (at least shared by the EC countries) in order to control and improve this threat, without loss for the economy. Mediterranean islands are characterized by harsh landscapes painted with strong colours, superb mountain scenery, woodland, fascinating coastlines and beaches, as well as places of great historical and archeological interest; they are very much suitable to different kinds of nature tourism. Ecotourism is defined as responsible travel to natural areas that conserves the environment and sustains the well-being of local people (BLANGY and EPLER WOOD, 1993). Nature tourism in 1989 generated approximately 7% of all international travel expenditures (CEBALLOS-LASCURAIN, 1993); potential benefits of ecotourism are generation of funds for protected areas, creation of jobs for people who live near protected areas, and promotion of environmental education and conservation awareness (BOO, 1993).

An exemplary case of ecotourism in Mediterranean islands is that reported by PITTET (1994) for Formentera (Baleares Is.); tourists conscious of the requirements of the environment and who adapt their behaviour to them contribute to the welfare of local people.

We need to inventory all the preserved coast areas of Mediterranean islands, to analyse speedly their biological-conservationist value using as ecological indicators well-known taxonomic groups (BRICHETTI and MASSA, this volume), and to propose to local governments alternative projects, which consent at the same time ecotouristic exploitation, economic growth and conservation of natural resources. Because much of the threatened biodiversity can be found in comparatively small areas, protection of these areas would ensure the survival of a high number of species, both animals and plants. Analysis of breeding bird distribution, of sites of concentrating migrators and of wintering habitats have revealed that they are good indicators of these key areas.

I conclude by proposing to the scientific community to contribute to this international inventory, and I recall that natural resources are a very important and unique tourist attraction; to do nothing in order to improve their degradation or to contribute to their destruction is a cultural crime like destroying a sculpture made by Michelangelo, as NORTON (1986) wrote: "*the damage done when a species becomes extinct is analogous to the damage done when a great work of art is destroyed*".

I

REFERENCES

BLANGY S. and EPLER WOOD M., 1993. Developing and implementing ecotourism guidelines for wildlands and neighboring communities. Pp. 32-54 *in* LINDBERG K. and HAWKINS D.E. (eds.), Ecotourism, a guide for planners and managers. Ecotourism Soc., Vermont, USA.

BOO E., 1993. Ecotourism planning for protected areas. Pp. 15-31 *in* LINDBERG K. and HAWKINS D.E. (eds.), Ecotourism, a guide for planners and managers. Ecotourism Soc., Vermont, USA .

CEBALLOS-LASCURAIN H., 1993. Ecotourism as a worldwide phenomenon. Pp. 12-14 *in* LINDBERG K. and HAWKINS D.E. (eds.), , Ecotourism, a guide for planners and managers. Ecotourism Soc., Vermont, USA

NORTON B.G., 1986. The preservation of species. The value of biological diversity. Princeton Univ. Press.

PITTET E., 1994. Ecotourism in Formentera, Archipelago of the Baleares. *Insula*, 3(1): 48-50.

World Travel and Tourism Council, 1992. The WTTC Report : travel and tourism in the world economy. Bruxelles

THREATENED HABITATS AS A CRITERION FOR SELECTING COASTAL PROTECTED AREAS IN THE MALTESE ISLANDS

Patrick J. SCHEMBRI

Department of Biology, University of Malta, Msida, Malta

Recognising that the sea is one of the Maltese Islands' main resources, recent environmental protection legislation pays particular attention to the coastal zone and shallow seas off the islands. Under this legislation, the terrestrial areas of three islands, and a number of coastal sites, have been declared nature reserves. However, at present there are no marine protected areas within Maltese territory. Marine activities are restricted in certain sea areas round the Maltese Islands, but this is for reasons of security. One factor hindering the establishment of marine protected areas is lack of knowledge as to which ecosystems are in need of protection. In order to address this deficiency, a survey was carried out to identify coastal and shallow water habitats which are threatened. The results of the survey are summarised below. For each habitat type recognised as in need of protection, status, exploitation and threats are reported upon in that order.

Mediolittoral bioconstructions

Status: Platforms formed by the alga *Neogoniolithon notarisii* and the vermetid *Dendropoma petraeum* are common on all gently sloping rocky shores. *Lithophyllum* cushions are only known from a few shores (for example, Xlendi, Gozo and Ghar Lapsi, Malta). These rocky shore bioconstructions are considered vulnerable on a Mediterranean scale (UNEP/IUCN/GIS POSIDONIE, 1990).

Exploitation: No direct exploitation.

Threats: The same as all local rocky shores, mainly from development.

Sea-grass (*Cymodocea nodosa* and *Posidonia oceanica*) meadows

Status: Although common and widespread round the Maltese Islands, in some areas, especially in enclosed or semi-enclosed bays receiving a variety of effluents and subject to certain activities, these meadows have regressed and eroded away, leaving in their place much impoverished thanatocoenoses.

Exploitation: Not exploited directly, except for certain types of fishing, but their high productivity makes them one of the most important local sublittoral community types, as in the rest of the Mediterranean (ROS *et al.*, 1985).

Threats: The main threats are: dredging, which causes both mechanical damage and also increases water turbidity and the rate of sedimentation; terrestrial run-off in enclosed bays, particularly that containing sediment and agricultural run-off; cooling water from the local power stations; the hypersaline discharge from reverse osmosis plants; nutrient-rich effluent from sewage; waste from fish-farms; bottom trawling; the use of heavy anchors, which physically damage the meadows; and the illegal use of explosives for fishing. Coastal developments have changed the current and sedimentary regimes in some areas (for example, Marsaxlokk Bay, Malta) and have caused regression of sea-grass meadows.

***Posidonia* "barrier reefs"**

Status: Only very few such formations are known locally. The best documented are those in Mellieha Bay (BORG and SCHEMBRI, 1993) and in Salina Bay, both in Malta.

Exploitation: Not exploited directly, however, these "reefs" are very important in protecting the shore from wave action by absorbing the energy of waves.

Threats: The same as sea-grass meadows in general, but particularly susceptible to mechanical damage, as for example, from boat anchors and moorings.

***Halophila stipulacea* meadows**

Status: Meadows of this Lessepsian immigrant are only known from two Maltese localities, the inner reaches of Marsaxlokk Bay, Malta (LANFRANCO, 1970) and Mgarr Harbour in Gozo. The populations at Marsaxlokk have regressed in recent years.

Exploitation: Not exploited.

Threats: Dredging works in connection with the new power station at Delimara, together with pollution resulting from the fishing harbour at Marsaxlokk, have caused a severe decline in the Halophila meadows growing in Marsaxlokk Bay.

Deep-water Cystoseira communities

Status: Deep-water Cystoseira communities based on *C.spinosa*, *C.dubia* and *C.zozteriodes*, are rare and poorly known in the Maltese Islands, however, it is suspected that they may be threatened, as in other parts of the Mediterranean (UNEP/IUCN/GIS POSIDONIE, 1990).

Exploitation: Not exploited directly, except for some types of fishing.

Threats: Most species of Cystoseira are sensitive to pollution, particularly to high phosphate levels and upper infralittoral communities are disappearing from some areas receiving organic pollution; deep-water communities may be similarly affected Other threats include changes in sedimentary and current regimes due to coastal developments, dumping, and fishing with explosives.

***Cladocora cespitosa* banks**

Status: In Malta this coral forms banks some 20 cm across. These were previously common but are now rare. Large and well-developed banks are particularly rare.

Exploitation: Collected for their curiosity value and for use as decorations in aquaria.

Threats: Overcollecting and mechanical damage from the use of heavy anchors and fishing gear; also, illegal fishing with explosives.

Maërl communities

Status: Apparently rare in the Maltese Islands, although this could be because these communities occur mainly in deep water. It is suspected that those occurring close to the transition zone between the lower infralittoral and the upper circalittoral may be threatened.

Exploitation: Not exploited directly, except for some types of fishing.

Threats: The main threat seems to be from bottom trawling although changes in the sedimentary regime due to coastal development may pose an additional threat in some areas.

Corallegene communities

Status: Occur in deep water (circalittoral) and poorly known locally. It is suspected that those occurring close to the transition zone between the lower infralittoral and the upper circalittoral may be threatened.

Exploitation and threats: The same as for maërl communities.

Caves

Status: Common in Maltese waters and different types exist, ranging from those close to the surface and open to the air, to deep grottoes and tunnels.

Exploitation: Not exploited directly, except for "sight-seeing" by tourist divers.

Threats: The main threat is from divers who enter the caves. These cause both mechanical damage to erect sessile forms, and death of the biota on the ceiling due to air bubbles from diving cylinders becoming trapped there.

REFERENCES

BORG, J.A. and SCHEMBRI, P.J., 1993. Report on a survey of the marine benthic communities of Mellieha Bay (northern Malta). Malta. Malta Coastal Environment Research Project (CERP).54 pp.

LANFRANCO, E., 1970. Occurrence of *Halophila stipulacea* (Forskal) Ascherson (Family: Hydrocharitacea) in Maltese waters. *The Maltese Naturalist*, Valletta 1(1): 16-17.

UNEP/IUCN/GIS POSIDONIE 1990. Livre rouge "Gérard Vuignier" des végétaux, peuplements et paysages marins menacés de Méditerranée. *MAP Technical Reports Series* 43 : 1-250.

ROS, J.D.; ROMERO, J.; BALLESTEROS, E. and GILI, J.M., 1985. Diving in blue water: the benthos. *In* : MARGALEF, R. [ed.] Key environments - the western Mediterranean. pp.233-295. Oxford: Pergamon.

PROPOSITIONS DE GESTION DU CHEPTEL CAPRIN EN GRÈCE INSULAIRE

Georgios M. TSIOURLIS

Université de Crète, Département de Biologie, Laboratoire d'Ecologie Terrestre.
P.O. Box.1470. 71110. Iraklion Crète, Grèce

Il est indéniable que la chèvre, utilisée abondamment dans la Grèce insulaire, est le seul animal pouvant tirer profit d'une végétation dégradée, sclérophylle et souvent épineuse. Les phytocénoses pâturées dans les îles de la Mer Egée sont les phrygana (formations basses à chaméphytes en coussinet à feuilles décidues -dimorphisme saisonnier- ou sclérophylles) et les maquis (matorrals) souvent dégradés (fourrés sempervirents à feuilles sclérophylles).

En général, les troupeaux, de 150 à 300 animaux, sont des unités familiales. Le mode le plus courant de gestion est le pâturage semi-contrôlé ou en quasi-liberté sur des surfaces de 1 à 3 km^2 (1-3ch./ha). Les seules interventions sont le regroupement quotidien du troupeau pendant la période d'allaitement et pendant la saison sèche pour l'abreuvement. Après 4 à 5 ans, le troupeau est déplacé sur des sites équivalents qui ont subi une faible charge animalière, ou qui étaient en jachère (plus rarement).

Le rendement est décevant : 5 ± 1 kg/ha/an en viande (poids vif) et 4 ± 1 kg/ha/an en fromage (d'après les résultats de MAGIORIS & TSIOURLIS, non publiés), soit moins du 1/5 des résultats obtenus en Grèce continentale du Nord.

L'effet de ce type de gestion est la dégradation des écosystèmes au niveau de la végétation et des sols. L'arrachage de toute strate au sol, en hiver et au printemps, a pour conséquence son dénuement. Le piétinement continu le tasse et le rend imperméable à l'eau météorique qui est amenée à ruisseler. Ces deux actions contribuent à l'amplification de l'érosion des sols en pente et entravent la régénération des espèces végétales.

L'exemple le plus frappant, à l'échelle d'une île entière, de la dégradation causée par le pâturage se rencontre dans le sud-est de la Mer Egée (Dodécanèse) à Kassos. Les flancs de montagnes sont complètement dénudés de végétation : la désertification de l'île commence par là. Le rendement du bétail est négatif, la mortalité élevée et des fourrages d'appoints sont nécessaires toute l'année.

En considérant *a priori* comme une nécessité, pour des raisons politico-socio-économiques, la conservation du cheptel caprin, il est impératif d'exercer un contrôle plus rigoureux sur son mode de gestion, visant à un meilleur rendement et à une protection des écosystèmes :

- Instauration d'un système rotatif de zones pâturées et jachères de 1an 1/2 à 2 ans, période qui semble être un palier dans l'augmentation de productivité du chêne kermès (*Quercus coccifera*; TSIOURLIS, 1986), principale espèce pâturée. Cependant, il ne faudrait pas prolonger la jachère, sinon la végétation changerait de structure et de nature (hauteur plus élevée, densité accrue) et deviendrait difficilement pâturable.
- Introduction et amélioration d'espèces graminales, bien que la réussite en climat semi-aride ne soit pas assurée.
- Au cas où un système rotatif ne pourrait pas être instauré, il faudrait réduire le pâturage d'une part au début du printemps et d'autre part lors des pluies intensives hivernales.
- Apport de fourrage d'appoint pendant les mois estivaux : son effet bénéfique a été vérifié expérimentalement à Naxos (MAGIORIS & TSIOURLIS, 1990). L'idéal serait de cultiver dans ce but les nombreux terrains agricoles et les oliveraies abandonnés, qui sont pour la plupart protégés par des murets et sont fort nombreux dans ces îles.
- S'il est possible de s'inquiéter davantage de la sauvegarde de l'environnement, tout en conservant éventuellement un certain élevage, on réduirait au moins de moitié la charge animalière, ce qui permettrait l'établissement d'un nouvel équilibre entre la végétation et le pâturage.
- Dans les cas extrêmes, comme à Kassos, une proposition plus radicale, exigeant des subventions importantes de l'Etat serait de supprimer complètement le cheptel caprin et ovin en pâturage libre et de ne permettre l'élevage que de quelques animaux par famille et ce, en enclos, puis de réintroduire progressivement, après 10 à 15 ans, des animaux dont la charge ne dépasserait pas l'unité à l'hectare, selon le mode de gestion proposé plus haut.

Notons que de nos jours, les subventions provenant de la Communauté Européenne encouragent l'élevage caprin. Cependant, la directive européenne concerne surtout la Grèce continentale où les maquis sont plus développés et les troupeaux pâturent presque exclusivement sur des parcours bien définis. De la sorte, les répercussions sur l'environnement sont minimes. Par contre, en Grèce insulaire, les subventions contribuent, dans une grande mesure, à entretenir un élevage aux conséquences désastreuses pour l'environnement naturel.

En réduisant la charge animalière ou en la supprimant pendant quelques années, nous permettrons à la végétation phryganique de coloniser à nouveau les terrains dénudés et aux maquis de se développer. Un exemple frappant de cette capacité est celui d'Armathia, petite île de 2,5km^2, à quelques miles marins de Kassos. Des cultures abandonnées depuis 3 à 5 ans sont recouvertes à plus de 50% par *Thymus capitatus*. Les pentes de l'île sont couvertes à 40% par un maquis bas.

Ainsi, on constate que les écosystèmes typiques méditerranéens sont aptes à se développer rapidement. Etant donné que dans ces régions les maquis peuvent êtres considérés, dans les conditions actuelles, comme climaciques ou du moins subclimaciques, et ce, surtout en ambiance semi-aride, ils constituent les seuls remparts à la désertification, en jouant un rôle primordial dans les phénomènes de lutte contre l'érosion et de régulation du régime des eaux.

REFERENCES

MAGIORIS St.N. and TSIOURLIS G.M., 1990. Annual evolution-activity and influence of the goat in two insular biotopes. Island of Naxos-Cyclades-Aegean sea-Greece. *Rapp. Comm. Int. Mer Médit.*, 32, 1.

TSIOURLIS G.M., 1986. Productivité du chêne kermès (*Quercus coccifera*) d'un phrygana insulaire (Naxos, Cyclades). *Rapp. Comm. Int. Mer Médit.*, 30, 2.

L

COMITÉ LUTTE CONTRE LES POLLUTIONS MARINES

Président : Michael SCOULLOS
Vice-Présidents : Giovanni PAGANO, Victor AXIAK

FACTORS INFLUENCING THE ACCUMULATION OF HEAVY METALS INTO THE COASTAL SEDIMENTS OF LESVOS ISLAND, GREECE

Michael O. ANGELIDIS and Maria ALOUPI

Department of Environmental Studies, University of the Aegean, Karadoni 17, 81100 Mytilene, Greece

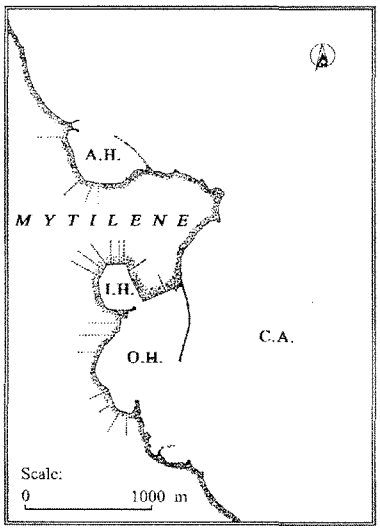


Figure 1. Study area

The urban effluents discharged into the marine coastal environment are carrying important loads of organic matter and metals (KLEIN *et al.*, 1974), in dissolved/colloidal or particulate form, which, after flocculation in the marine environment (GIBBS, 1986), settle to the bottom and are incorporated into the coastal sediments. A study conducted in the marine coastal environment of Lesvos island, near the city/harbour of Mytilene, investigated the concentrations of organic matter and heavy metals in the sediments of the area and attempted to identify the factors that influence their accumulation. The analytical techniques are presented elsewhere (ANGELIDIS *et al.*, 1994). The study area is presented in Figure 1. Along this coast, 25 sewage outfalls are discharging urban effluents containing important metal concentrations. In the Table 1 are presented the range of organic carbon and metal concentrations (0.5 N HCl extractable fraction) in four different areas : the inner harbour (IH), the outer harbour (OH), the ancient harbour (AH) and the coastal area (CA).

In general, Cu and Zn which are the most effluent associated among the metals analyzed (KLEIN *et al.*, 1974), presented higher concentrations in the harbour sediments compared to the coastal area sediments. However, among the three harbours, the inner harbour presented the highest and the ancient harbour the lowest metal concentrations. Furthermore, the sediments from the ancient harbour had very low content of fine sediments and organic carbon, although the area also receives city effluents through a number of sewage outfalls (Figure 1). Since fine particles tend to transport the most important metal load in the sediments (GIBBS, 1977), the lack of fine sedimentary material in the ancient harbour, seems to be a key factor for the low metal concentrations found there. Because the area of the ancient harbour of Mytilene is located at the north of the city and is open to the prevailing strong northern winds of the Aegean sea, wind induced waves may resuspend and remove the finer particulate matter as well as the effluent-born flocculated colloids from the area, removing thus the greater metal load. Organic carbon load is also small in the ancient harbour sediments, probably because of the same removal process of the organic rich particulate matter, as well as because of the oxidation which is induced by the rapid change of the water masses. On the other hand, in the sheltered area of the inner harbour (as well as in the western part of the outer harbour near the city shore), the organic and metal-rich fine particulate matter settles to the bottom and remains generally undisturbed, leading thus to the accumulation of pollutants into the harbour mud. From the above preliminary investigation the following conclusions can be drawn:

	IH	OH	AH	CA
silt-clay %	65.9-95.6	26.2-78.5	0.3-3.6	27.6-75.6
O.C %	3.3-4.8	1.9-4.3	0.1-0.9	1.4-3.4
Cr µg/g	15.8-19.3	13.7-17.1	13.2-13.4	13.2-16.0
Cu µg/g	30.7-58.9	16.7-30.4	12.6-32.7	9.4-17.5
Fe mg/g	3.7-4.2	1.8-4.0	1.8-2.3	2.3-3.8
Mn µg/g	99.7-111	103-133	87.8-92.9	95.4-133
Zn µg/g	75.0-157	27.8-105	68.8-89.3	27.9-52.4

Table 1. Concentrations of metals, O.C. and particle size in coastal sediments of Mytilene.

1. The concentrations of some metals, namely Cu and Zn, may be considerably high in the sheltered waters of harbours and anchorages receiving urban effluents and city runoff.

2. The low hydrodynamism of a coastal area seems to be a crucial parameter which allows the metal and O.C. enrichment of the sediments. On the other hand, in the exposed near shore areas, fine material resuspension and transport do not allow metal accumulation in the sediments, although the area may also receive urban effluents.

3. In the absence of other metal producing activities, urban effluents constitute an important source of metals for the marine environment. Therefore the sheltered marine areas (harbours and anchorages) near urban and tourist developments of the Mediterranean coast, may become potential metal deposits affecting thus the quality of the marine coastal environment.

REFERENCES

ANGELIDIS M.O., M. ALOUPI, I. PAPAGIANNIS, A. PAPAVASILIOU, 1994. Col. Intern. "Villes des rivages et Environnement littoral mediterranéen", (in press).

GIBB. R.J., 1977. *Geol. Soc. Amer. Bull.*, 88 : 829-843.

GIBBS R.J., 1986. *Mar. Chem.*, 18 : 149-159.

KLEIN L.A., M. LANG, N. NASH, S.L. KIRCHNER, 1974. *J.W.P.C.F.*, 46 : 2653-2662.

FIRST REPORT ON BIOMONITORING OF COASTAL CONTAMINATION BY TRIBUTYLTIN IN THE MEDITERRANEAN USING IMPOSEX IN A NEOGASTROPOD

V. AXIAK[1], D. MICALLEF[1], A. VELLA[2], P. CHIRCOP[1], B. MINTOFF[2]

[1] Marine Ecotoxicology Laboratory, Department of Biology. [2] Department of Chemistry, University of Malta, Msida, Malta

Being the active biocide in antifouling paints, very high levels of tributyltin (TBT) and its derivatives have been reported in harbour areas and yacht marinas along the Mediterranean. Chemical analysis of organotins at low environmental levels which may still be expected to cause some biological impact (ie. less than 50 ng l^{-1}), pose several analytical problems. Such problems have stimulated the use of highly specific biological responses to TBT as tools for biomonitoring purposes.

STATION:	1	2	3	4	5	6	7	8	9
% imposex in ♀	30	60	60	94	100	100	100	100	100
RPS Index [%]	0	13	6	2	93	102	107	86	68
VDS Index (mean)	0.5	1.9	1.8	2.1	4.7	4.8	4.7	4.2	3.9
% ♀ with split capsule glands	0	10	20	0	67	72	62	16	0

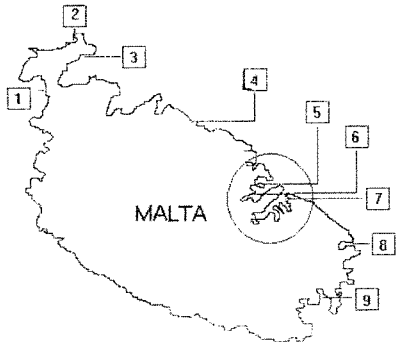


Fig.1. Imposex in *H. trunculus* as expressed in various indices, at different sites. Harbour area are circled.

Imposex, or the development of additional male sex organs in prosobranch gastropods, has been widely used as a biomonitoring tool for TBT outside the Mediterranean. To date, no other xenobiotic except TBT, is known to cause prosobranchial imposex. The present study reports on the first biomonitoring survey of TBT levels in Mediterranean coastal waters using imposex induction in *Hexaplex trunculus* as an index. This species is one of the most common muricid in the Mediterranean. 600 specimens of *H. trunculus* were collected by divers from 9 coastal stations along the north-eastern coastline of Malta (Central Mediterranean) during the period Oct.-Dec. 1992 (Fig. 1). The degree of imposex was quantified by various indices, including : the Relative Penis Size Index (RPS) which is the ratio between the cubed mean penis length in imposexed females to that in males for a given population; and the Vas Deferens Sequence (VDS) Index, whereby imposex development is divided into various stages of vas deferens development, with each stage being given a score. A synthesis of the data is presented in Fig.1. All populations showed some degree of imposex., which was however mostly evident in harbour areas exposed to release of TBT from yacht marinas and ship-repairing yards. Stations which were located downstream with respect of the harbour areas (the prevalent surface coastal water currents being from the NW), also exhibited significant degrees of imposex induction in this species. This phenomenon was moreover related to the levels of TBT in the organisms as well as in sediments. Details of analytical methods and levels of butyltins in biota and sediments are presented elsewhere (AXIAK *et al.*, in press). Fig.2 shows the relationship between the levels of TBT in digestive glands/gonads of females and RPS indices, with the estimated logarithmic correlation line also being shown. The various imposex indices were found to increase sharply at very low levels of butyltins and then to level off also at relatively low levels of the contaminants. Based on a logarithmic correlation line, a 50% index value for RPS was reached at 6 ng Sn g^{-1} dry weight (DW) in the digestive gland/gonad, and at estimated levels of as low as 3.5 ng Sn g^{-1} DW for TBT in whole soft flesh of females. In fact there is evidence to suggest that of all the neogastropod species investigated so far, this species is the most sensitive with respect to its biological response to TBT. This is evident from a comparative review of the relative sensitivities in imposex response to TBT levels in a series of neogastropods as shown by AXIAK *et al.* (in press).

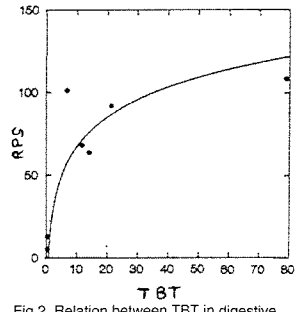


Fig.2. Relation between TBT in digestive gland/gonad of females (ng Sn/g dry weight) and RPS index (%)

Most of the body burdens of TBT (but not of DBT and MBT) were generally found in the digestive gland of exposed snails, indicating that feeding is the major route of uptake of this contaminant for this test species. Females tend to accumulate more TBT than males. No preferential female mortalities was recorded in populations exposed to high levels of TBT. However, a reported shift in the size frequency distribution of animals in contaminated sites, towards bigger snails, may suggest reduced reproductive potential. Imposex in females may lead to sterility either through the occlusion of the vagina or the splitting of the capsule gland. While vagina occlusion does not occur in this species, the majority of females in the highly contaminated sites exhibited split capsule glands. Further data is required to assess whether imposex in this species is leading to sterility of females.

This study has shown that imposex induction in this test species is a highly specific biomarker response; it may be easily quantified; it is extremely sensitive to very low levels of butyltins; it is fast and cost-effective and as such satisfies all criteria for a useful biomonitoring tool which may be applicable to the whole Mediterranean.

This work was partly supported by the Commission of European Communities through its MedSPA programme under contract number MedSPA-91-1/UK/002/INT/06.

REFERENCES

AXIAK V., VELLA A.J., MICALLEF, D., CHIRCOP P. and MINTOFF B. Imposex in *Hexaplex trunculus* : First results on biomonitoring of TBT in the Mediterranean. Marine Biology. In press.

L

THE CASE FOR A BIOMONITORING PROGRAMME OF POLLUTION IN THE MEDITERRANEAN*

V. AXIAK[1] and M. SCOULLOS[2]

[1] Marine Ecotoxicology Laboratory, Dep.of Biology, Univ. of Malta, Malta
[2] Department of Chemistry, University of Athens, Greece

Monitoring programmes absorb a lot of resources both human and financial in order to secure the reliable assessment of quality of the environment and "health'" of ecosystems. Most of the presently operated projects focusing only on chemical parameters (often only of a limited range of suspected contaminants) are unable to provide adequate information to fulfil the aforementioned objective. Therefore it seems logical that a proper monitoring should include the right mixture of chemical and biological parameters, that is the assessment of the quality of the environment also on the basis of the response of organisms to pollution or other stressors. Any cost-effective environmental monitoring programme must integrate a wide range of chemical and biological monitoring techniques, thereby avoiding replication and providing the sufficient scientific information required to predict the risk of damage to living resources or to man at the earliest possible stage.

The range of biomarkers applicable to the Mediterranean has been recently reviewed by SCOULLOS (1993) and AXIAK (1993). The types of bioassays which are currently available and which have shown a proven potential for field monitoring are included in table 1. A wider range of bioassays are indeed available, but these are either of dubious specificity, sensitivity or ecological relevance or have not been sufficiently tested yet in the field. At this stage of bioassay development, it is possible to develop an effective biomonitoring programme, which would be integrated in the current chemical monitoring programmes, and which would be based on the use of biochemical markers such as MFO, methallothioneins, and cellular changes. A pilot biomonitoring programme has been recently proposed to be introduced within the Mediterranean Action Plan. The success of this pilot project will initially depend on the political will and availability of adequate resources for its implementation.

The limitations and inadequacies of the present chemical monitoring programme include : insufficient data quality control, incomplete geographical coverage and insufficient implementation of the required standardized methodologies. The realization of such limitations will be an essential prerequisite in optimizing the present monitoring strategies and in ensuring the effective integration of a biomonitoring component in such a programme. Ultimately, the success of any region-wide environmental monitoring programme will depend on its compatibility with on-going national monitoring programmes and on its ability to communicate effectively relevant information on the state of the environment to the decision makers and environmental authorities.

Table 1. A comparative review of some bioassays and their potential for use in environmental monitoring programmes in the Mediterranean.

	Mixed Function Oxygenases	Methallo-thioneins	Cellular Changes	Genetic Changes	Scope For Growth	Species Diversity abundance
Organisms used	Mostly fish	Mostly mussels	Various	Various	Mostly bivalves	
Specificity of response	Organics	Heavy metals	General	General	General	General
Sensitivity	Varies	High	Medium	Varies	High	High
Dose-response relationship	Good	Good	Low	Unknown	Good	Low
Ability to monitor recovery	Unknown	Unknown	Unknown	Unknown	High	High
Ecological significance	Low	Medium	Medium	Unknown	High	High
Sampling validity	High	High	Medium	Unknown	High	Varies
Time of response	Hours	Hours - days	Days-months	Days-months	Days-months	Months
Costs	Medium	Medium	Low	Medium	Medium	Low-Medium
Relative ease	Complex	Complex	Medium	Medium-Complex	Medium	Labour intensive
Potential for monitoring	High	High	Medium	Unknown	High	High

Adapted from HOWELL et al. (1990)

REFERENCES

SCOULLOS, M. 1993. Mediterranean Pollution : Chemical and biological aspects. *In* : Pollution of the Mediterranean Sea. Ed. by F. Briand. CIESM and Univ. de la Méditerranée, STOA Report, European Parliament, pp. 37-67.

AXIAK, V. 1993. The reliability and potential of biological indicators, ibid, 69-73.

HOWELLS G., GRAY D., and WELLS P. G., 1990. An analytical approach to the assessment of long-term effects of low levels of contaminants in the marine environment. *Mar. Pol. Bull.* 21(8) : 371-37.

** An introduction to the round table discussion on monitoring.*

HEAVY METALS IN THE SUPERFICIAL SEDIMENTS OF BOUISMAIL BAY

B. BOUDJELLAL, N. FREHAT, M. DJILLALI & M. AZZOUZ

ISMAL, Laboratory of Chemistry and Marine Pollution. P.B. 90. Algiers, Algery

In order to estimate the contamination degree of the Algerian coasts by heavy metal, Bouismail bay has been the object of a preliminary study during the summer 1991. The studied zone was sampled in eight radials among which six were in direct relation with the rivers (Mazafran and Beni-messous) (fig.1). Surface sediment samples were colleted by using a Van Veen grab, which takes representative samples by 0-10 cm layer. From the dried sediment samples a quantity of 1 g (< 63 µm) was mineralized with mixture of HCL-HNO_3 (3-1 v/v Ridel-de Haën) during two hours at 120° under a flowing-back column. This treatment methods are those suggested by UNEP/IAEA (1985a, 1985b and 1986). Cadmium, Chromium, Copper, Manganese, Lead, Mercury and Zinc were the metals analysed. The inter-stantardization is realized on lyophilised sediment provided by the IAEA (MONACO) and coded SDM2/TM. The analysis is led by a Perkin-Elmer 2380 GFAAS.

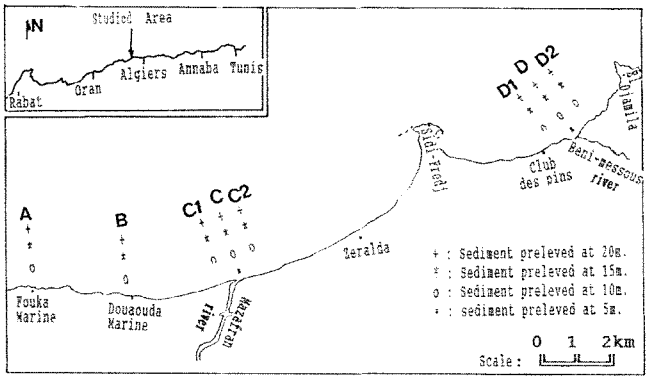


Fig. 1. Bouismail Bay : sampling stations

The high levels of Hg and Pb reflect the existence of pollution sources, essentially in front of the Mazafran river where we found the highest values. The strong variation of these metals is in relation to the important intake of this river which marks out Bouismail bay. Cd variation is due to the diversity of pollution sources, important agricultural activity, urban casting up, etc., on one side and on the other side to the natural variations (DESSAINT, 1987).

Mn and Cr present normal values and their distribution is uniform in the studied zone. However, we may point out that the floculation effect is very important for Mn (rapid precipation of this metal to the interface fresh water/salt water). This has been already shown by CHESTER and STONER (1975) in sediments from the lower Severn Estuary and Bristol Channel. Finally Zn and Cu concentrations are variable and the highest are located at the west of Mazafran river. This augmentation is probably due to an anthropic input principally caused by this river, and may also be due to the fertility of this sector in organic substances.

Radials (Bottoms nature)	Hg	Pb	Cd	Mn	Cr	Cu	Zn
A (fine sand)	00.24	14.84	00.56	449.63	72.49	23.52	107.00
B (fine sand)	00.42	16.16	00.27	495.85	73.70	55.16	125.60
C (muddy sand)	00.44	31.42	00.34	417.15	71.85	22.62	72.62
C1(fine sand)	00.46	25.79	00.95	504.55	73.52	24.82	103.00
C2(fine sand with shells fragments)	00.40	25.16	00.13	507.30	73.94	22.59	103.59
D (fine sand)	00.045	15.17	00.49	468.25	70.39	15.59	65.30
D1 (fine sand)	00.065	15.48	00.15	484.15	72.33	16.23	65.00
D2 (fine sand)	00.055	18.39	00.33	481.00	73.50	20.10	85.87
Mean	00.265	20.30	00.40	475.98	72.71	25.07	91.00
± SD	00.17	05.89	00.25	28.50	01.12	11.79	20.78

Table 1. Average concentration of metalic element in the superficial sediments of Bouismail Bay (µg/g. Dry weight)

The analysis of the heavy metals studied in the superficial sediments of Bouismail bay shows an irregularity in their repartitions. The continental input directly sheded into the bay or indirectly by the slants of the river, the heterogeneity of the bottom sediments and the abundance of biogene particles in this sector are the causes of this variation. However, the metalic pollution at the level of the bay is not alarming and is rather weak in comparison to other sites of the Algerian coast. However, considering the evolution of the agricultural activities in this region and the massive urbanisation along the Bouismail coast, further pollution may be expected for the future.

REFERENCES

CHESTER R. and STONER J. M., 1975. *Mar. Pollut. Bull.*,6 : 92-96.

DESSAINT F., 1987. *J. Rech. Oceanogr.* 12, 3 and 4 : 90 - 93.

UNEP/AIEA., 1985(a). Reference Methods for Marine pollution Studies. N°31, UNEP, 13 p.

UNEP/AIEA., 1985(b). Reference Methods for Marine pollution Studies. N°33, UNEP, 13 p.

UNEP/AIEA., (1986). Reference Methods for Marine pollution Studies. N°38, UNEP, 10 p.

COMPARED BIOACCUMULATION OF MERCURY BETWEEN THE MARINE PHANEROGAM *POSIDONIA OCEANICA* AND THE HERBIVOROUS FISH *SARPA SALPA* : PRELIMINARY RESULTS

Xavier BOUGEROL[1], Gérard PERGENT[1], Jean GIBERT[2]

[1] EP CNRS 0075, Ecosystèmes Littoraux, Univ. de Corse, BP 52, 20250 Corte, France
[2] Lab. Départemental d'Analyses Vétérinaires, rue F. Pietri, 20090 Ajaccio, France

Because of its high toxicity and its characteristic bioaccumulation properties, Mercury appears as one of the most watched substances when it comes to its discharge into the natural environment. In the Mediterranean, Barcelona Protocole (16-2-1976) places it fourth on the list of priority substances. Experimental results of bioaccumulation and mercury levels found in marine organisms within the natural environment agree to show a strong retention of mercury and of methyl mercury, by the biomass. Concentration levels in sea water vary between about 10^3 to 10^6 (COSSA *et al.*, 1990). Because of constraints linked to the direct analysis of levels of trace metals in sea water (variability in space and time, heterogeneity of concentrations of water masses) the interpretation of measurement of mercury concentration in sea water is not easily achieved. The use of characteristic live species (e.g. biological indicators), which integrate environment variations over much longer periods of time allows a better evaluation of contamination of the environment. Marine phanerogams such as *Posidonia oceanica* (L) Delile usually provide a good representation of mercury levels in sea water. Also, the analysis of mercury levels in various compartments of the ecosystem could provide some indications about bioaccumulation phenomena and generally speaking on the concentration and transfer of stable pollutants within a benthic food web in coastal areas.

In this first study, three sites, situated at equivalent -10 m depths, were selected :
- one site situated in the vicinity of the sewage outfalls of the Marseilles Depuration Station (Cortiou)
- two sites along the Corsican Coast : at Canari, situated near the waste water outfall of an asbestos mine, and at Calvi, which is a less developed area.

Three replicates of 15 bundles of *P. oceanica* were collected on each site in October 1992. In Calvi, five *Sarpa salpa* individuals were removed at the same time. *P. oceanica* leaves were separated according to the type of leaves (adult and intermediate *in* GIRAUD, 1977), their age (rank) and tissue (sheaths and blades). Three types of sub-samples were also taken from *S. salpa* : liver, gills and muscle. Mineralization of samples was realised in Nalgene FEP Teflon bottles, using the microwave method, in a mixture of sulfonitric acid and oxygenated water. Mercury measurement was realised with the help of a flameless atomic absorption spectrometer (MAS 50 of Perkin Elmer).

Mercury levels (in µg/g dry weight), in *P. oceanica* (Figure 1), showed :
(i) significant differences according to the studied tissue, sheaths presented the most contamination (0.098 ± 0.018 µg/g dw), whereas the blades of adult leaves showed a mean concentration of 0.026 ± 0.006 µg/g dw,
(ii) higher mercury levels in older tissues; concentrations were still more important in the blades of adult leaves (0.026 ± 0.006 µg/g dw) than in that of intermediate leaves (0.015 ± 0.005 µg/g dw).
(iii) except for adult sheath, no significant differences according to the studied sites.
In *S. salpa*, concentration was maximal in the liver (0.857 µg/g dw, Figure 2); the amount noted in the gills (0.090 µg/g dw) and the muscles (0.050 µg/g dw) being smaller, but still superior to that measured in the blades of *P. oceanica* in Calvi (0.015 µg/g dw).

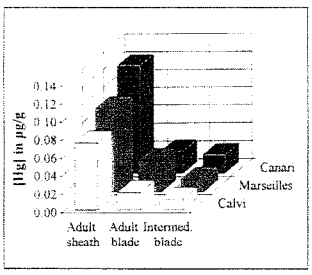


Fig. 1 : Mercury concentration in *P. oceanica* according to studied site and tissue

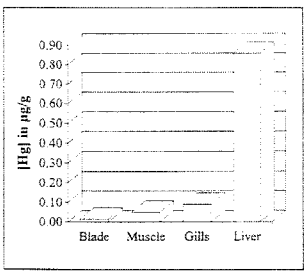


Fig. 2 : Mercury concentration in *P. oceanica* (blade) and *S. salpa* in Calvi.

Concentrations found in the various tissues of *P. oceanica* confirm that the distribution of pollutants generally varies according to the studied tissue. It appears that mercury accumulates preferably at the level of the sheath. As for the blades, mercury levels seem correlated to the age of the leaves (the older leaves being more contaminated); this corroborates the observations made on other phanerogams, which showed that accumulation depends more on the age of the leaves than on the variations of metal concentration in the environment (WARD 1987). Similar observations were demonstrated with radionuclides (CALMET *et al.*, 1991). Even though there appear to be not always significant differences between the sites (e.g. adult and intermediate blade), it must be noted that the lowest levels were found to be in the Calvi area, which is the less developed zone. Although the fish *S. salpa* is not an exclusive consumer of *P. oceanica*, this phanerogam constitute an important part of its diet. Thus, levels measured in different tissues of *S. salpa* can be compared in relation to those measured in the blades of *P. oceanica* leaves. Mercury accumulation is indeed maximal in the liver, storing up and metabolisation organ, with a concentration factor which appeared to be superior to 57. For the gills and muscles, it is respectively 6 and 3. In absolute numbers, mercury concentration in the muscles of *S. salpa* (0.05 µg/g dw, i.e. about 0.015 µg/g in fresh weight) is greatly inferior to the levels found in other sectors of the Mediterranean in this species (0.061 µg/g fw in UNEP,1987), which confirmed the choice of our reference site.

ACKNOWLEDGEMENTS. This study constituted part of the European Communities Commission (STEP C0063) and ANVAR programmes.

REFERENCES

AUGIER H., GILLES G., RAMONDA G., 1978. Recherche sur la pollution mercurielle dans le golfe de Fos (Méditerranée, France). *Rev. internation. Océanogr. méd.*, 51-52 : 55-69.
CALMET D., CHARMASSON S., GONTIER G., MEINESZ A., BOUDOURESQUE C.F., 1991. Chernobyl Radionuclides in *P. oceanica*, 1986-1987. *J. Environ. Radioactivity*, 13 : 157-173.
COSSA D., THIBAUD Y., ROMEO M., GNASSA-BARELLI M., 1990. Le mercure en milieu marin. Biogéochimie et écotoxicologie. Rapport scientifique technique IFREMER, 19 : 1-130.
GIRAUD G., 1977. Contribution à la description et à la phénologie quantitative des herbiers à *P. oceanica* (L.) Delile. Thèse Doctorat 3ème cycle, Université Aix-Marseille II, Fr. : 1-150.
UNEP, 1987. Assessment of the state of pollution of the Mediterranean sea by Mercury and Mercury compounds. *MAP Technical Reports*, 18 : 1-350.
WARD T.J., 1987. Temporal variation of metals in the seagrass *Posidonia australis* and its potential as a sentinel accumulator near a lead smelter. *Marine Biology*, 95 : 315-321.

APPORTS EN HYDROCARBURES A LA MÉDITERRANEÉE NORD-OCCIDENTALE PAR LE FLEUVE RHÔNE

BOULOUBASSI I.[1] et SALIOT A.[2]

[1] Département de Géologie et d'Océanographie de l'Université de Bordeaux I, avenue des Facultés, 33405 Talence Cedex, France
[2] Laboratoire de Physique et Chimie Marines de l'Université Pierre et Marie Curie, Tour 24, 4, Place Jussieu, 75252 Paris Cedex 05, France

La Méditerranée reste une des zones océaniques les plus concernées par les pollutions dont l'influence est exacerbée par sa nature semi-fermée et le développement de ses pays riverains. La pollution par les hydrocarbures a été soulignée depuis longtemps comme l'une des plus préoccupantes (ZSOLNAY, 1979; HO *et al.*, 1982; UNEP, 1989; BURNS et SALIOT, 1986; ALBAIGES *et al.*, 1987). Les principaux vecteurs ont été identifiés : transport et apports chroniques liés aux industries côtières et au transport maritime (UNEP, 1989), atmosphère (SICRE *et al.*, 1987 ; SIMO *et al.*, 1992), fleuves et rivières (BOULOUBASSI et SALIOT, 1991 ; LIPIATOU et SALIOT, 1991).

Depuis plusieurs années, nous dressons un bilan des apports en hydrocarbures pétrogéniques et pyrolytiques à la Méditerranée nord-occidentale par le fleuve Rhône, le plus grand apport d'eau douce à la Méditerranée avec un débit moyen de 1650 m^3/s et un apport sédimentaire de 4-6x10 tonnes/an. Ce bilan est centré sur une estimation des différents apports (hydrocarbures pétroliers, hydrocarbures d'origine pyrolytique), en mettant en évidence les variations en fonction de la saison et du débit du fleuve et en étudiant les processus de transport par les phases dissoute et particulaire.

Nous rapportons ici les résultats obtenus lors de trois campagnes effectuées à la fin de l'été 1986, en hiver et au printemps 1987, permettant le prélèvement et la séparation des phases dissoute et particulaire (> 0,7 µm). Ces deux phases ont été étudiées pour leur contenu en hydrocarbures aliphatiques (NAH) et aromatiques polycyliques (HAP) par une combinaison des techniques suivantes : fractionnement des HAP par chromatographie liquide haute performance, analyse qualitative et quantitative par chromatographie en phase gazeuse et chromatographie en phase gazeuse couplée à la spectrométrie de masse.

Les concentrations en HNA associés à la phase particulaire (P) varient de 1 à 17 µg/l, soit de 240 à 860 µg/g de suspensions. Les HNA particulaires se présentent généralement comme un mélange de produits pétrogéniques et d'apports biogéniques autochtones et allochtones, ces derniers variant largement avec la saison. Les concentrations en HNA dans la phase dissoute (D) varient de 2,2 à 15,7 µg/l et sont systématiquement plus importantes que celles enregistrées dans la phase particulaire (P). Les valeurs du rapport P/D varient de 0,09 à 0,52 en septembre 1986, de 0,28 à 0,91 en janvier 1987 et de 0,10 à 0,88 en juin 1987. Les fortes teneurs en n-alcanes et leur profil, les valeurs du rapport composés non résolus/résolus (4,2-8,9) et la présence de hopanes 22S, 22R 17αH-21αH (en septembre) suggèrent des origines pétrogéniques et microbiologiques. La présence d'une série d'alcanes ramifiés iso et anteiso témoigne d'une bioconversion récente d'alcanes d'origine fossile à courte chaîne carbonée.

Les concentrations en HAP majeurs non substitués associés à la phase particulaire varient de 1 à 20 ng/l, soit de 0,4 à 6 µg/g. Les variations saisonnières indiquent de forts apports en hiver et en fin d'été. Les HAP sont essentiellement d'origine pyrolytique. Une forte décroissance des concentrations est observée en allant du fleuve vers le large. Dans la phase dissoute, les HAP sont plus abondants que ceux associés aux particules en suspension. Les teneurs varient de 4 à 119 ng/l avec des maxima observés en hiver. Dans cette phase, l'origine fossile est généralement prédominante. Ces données indiquent un découplage qualitatif et quantitatif important pour les HNA et les HAP dans les deux phases particulaire et dissoute. Ceci souligne la nécessité de mener des analyses simultanées des deux phases pour déterminer de façon réaliste l'origine, le flux et le devenir des hydrocarbures véhiculés par un fleuve dans les zones côtières. Par ailleurs, l'estimation du coefficient de partage *in situ* montre des écarts significatifs par rapport au modèle simple de partage des HAP entre les phases dissoute et particulaire (BOULOUBASSI et SALIOT, 1993).

Les apports annuels en hydrocarbures peuvent être estimés sur la base du débit liquide du Rhône à 800 tonnes /an pour les HNA, dont plus de 60% sont véhiculés par la phase dissoute et à 11,7 tonnes /an pour les HAP, dont plus de 85% sont véhiculés par la phase dissoute. Il s'agit ici d'un bilan préliminaire, basé sur le débit liquide et dressé à partir de campagnes caractérisées par un débit relativement faible. Pour des estimations plus réalistes et complètes, il conviendrait d'examiner également les périodes de crue, un travail en cours de réalisation.

REFERENCES

ALBAIGES J., FARRAN A., SOLER M., GALLIFA A. and MARTIN P., 1987. Accumulation and distribution of biogenic and pollutant hydrocarbons. PCBs and DDT in tissues of Western Mediterranean fishes. *Mar. Environ. Res.*, 22 : 1-18.
BOULOUBASSI I. and SALIOT A., 1991. Composition and sources of dissolved and particulate PAH in surface waters from the Rhone delta (NW Mediterranean). *Mar. Pollut. Bull.*, 12 : 588-594.
BOULOUBASSI I. and SALIOT A., 1993. Aquatic distribution and origin of PAH in coastal deltaic waters. *In* : Polycyclic Aromatic Compounds. Synthesis, Properties, Analytical Measurements, Occurrence and Biological Effects. GARRIGUES P. and LAMOTTE M., eds., Gordon and Breach, pp. 379-388.
BURNS K.A. and SALIOT A., 1986. Petroleum hydrocarbons in the Mediterranean Sea : a mass balance. *Mar. Chem.*, 20 : 141-157.
HO R., MARTY J.C. and SALIOT A. 1982. Hydrocarbons in the Western Mediterranean Sea, 1981. *Intern. J. Environ. Anal. Chem.*, 12 : 81-98.
LIPIATOU E. and SALIOT A., 1991. Hydrocarbon contamination of the Rhone delta and Western Mediterranean. *Mar. Pollut. Bull.*, 22 : 297-304.
SICRE M.A., MARTY J.C., SALIOT A., APARICIO X., GRIMALT J. and ALBAIGES J., 1987.Aliphatic and aromatic hydrocarbons in different sized aerosols over the Mediterranean Sea : occurrence and origin. *Atmosph. Environ.*, 21 : 2247-2259.
SIMO R., GRIMALT J., COLOM-ALTES M. and ALBAIGES J., 1992. Major biogenic and anthropogenic lipids in N.W. Mediterranean aerosols. *Water Pollution Research Reports*, 28 : 247-257.
UNEP (United Nations Environment Programme) (1989) State of the Mediterranean Marine Environment. MAP Technical Report Series n° 28. UNEP, Geneva, 97 pp.
ZSOLNAY A., 1979. Hydrocarbons in the Mediterranean Sea, 1974-1975. *Mar. Chem.*, 7 : 343-352.

L

ATMOSPHERIC FLUXES OF HEAVY METAL CONTAMINANTS TO THE VENICE LAGOON

J. Kirk COCHRAN[1], Mauro FRIGNANI[2] and Marco SALAMANCA[1,3]

[1] Marine Sciences Research Center, State Univ. of Stony Brook, New York, USA
[2] Istituto per la Geologia Marina, CNR, Via Gobetti 101, 40129 Bologna, Italy
[3] Universidad de Concepcion, Concepcion, Chile

Salt marshes that are flooded only by extreme high tides are exposed to the atmosphere most of the time and thus record the atmospheric fluxes of contaminants to coastal areas (McCAFFREY and THOMSON, 1980). In order to obtain the atmospheric fluxes of some anthropogenic heavy metals to the Venice Lagoon, we collected a stalt marsh core in October 1992, from a site near S. Erasmo. The core was sectioned and analyzed for the naturally occurring radionuclide ^{210}Pb (half-life = 22.4 y) and trace metals (Fe, Mn, Ag, Cd, Ni, Pb, Zn). The chronology for the core was obtained using the constant flux method (APPLEBY and OLDFIELD, 1978; McCAFFREY and THOMSON, 1980). This method assumes a constant flux of ^{210}Pb from the atmosphere to the marsh surface. The inventory of unsupported ^{210}Pb in the core (25 dpm cm^{-2}) agrees well with prior analyses of ^{210}Pb inventories in marsh cores from the northern part of the lagoon (18-25 dpm cm^{-2}, BATTISTON *et al.*, 1988) as well as with predicted atmospheric fluxes to the site (TUREKIAN *et al.*, 1977).

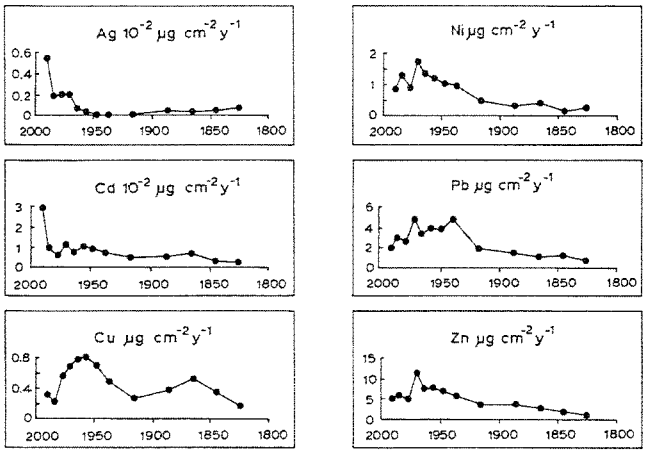


Fig. 1 - Variation of excess metal fluxes as a function of time.

The mass accretion rate of the marsh has varied over time, from 0.10 g cm^{-2} y-1 to 0.20 g cm^{-2} y^{-1}. At present the marsh is accreting at an accumulation rate equivalent to 0.17 cm y^{-1}, comparable to the eustatic rise in sea level. Fluxes of excess metals, defined as the fractions of metals above pre-industrial background levels observed at depth in the core, have varied significantly over time (Fig. 1). Several patterns are evident : fluxes of excess Ag and Cd show increases to the present, Ni and Zn show increases to about 1970 with decreases to the present, Cu displays a maximum flux at about 1960 followed by a decrease, and Pb shows increases to a period of relatively constant values (from 1940-1970) with recent decreases. These patterns reflect both regional trends in the atmospheric transport of trace metals and local inputs from the industrial development at Porto Marghera and Mestre.

Table 1. Comparison of ∑Excess Metal/∑Excess ^{210}Pb ratios in marsh and Venice Lagoon sediments.

	Pb	Zn	Cu	Ni
Marsh	18	32	3	5
Lagoon :				
S. Erasmo	14±8	49±23	13±7	37±46
Campalto	39±6	300±300	25±13	24±10
Cona	19	40	12	19

Comparison of inventories of excess ^{210}Pb in the marsh core and in subtidal sediments from the Venice Lagoon shows that, on average, ^{210}Pb input to the lagoon is dominated by the atmospheric flux (Table 1). Redistribution of sediments and associated ^{210}Pb and trace metals by physical and biological reworking of lagoonal sediments causes local variations in inventories, and ratios of excess metal inventories to excess ^{210}Pb inventories can better permit source variations in metal inputs to be resolved. Ratios of metal inventories to ^{210}Pb inventories demonstrate that point source inputs of metals are evident in lagoon sediments near the mainland, but that atmospheric inputs tend to dominate in the northern and eastern portions of the lagoon.

ACKNOWLEDGMENTS

The authors are endebted with R. Zonta, L. Zaggia and the technicians of the Istituto per lo Studio della Dinamica delle Grandi Masse (CNR, Venice) for the assistance during sampling operations. L. Zaggia determined marsh sediment densities. L. Bellucci and S. Lin carried out most sample preparations and many ^{210}Pb analyses. H. Muntau was responsible of metal determinations in sediment cores. The research is part of the Project "Sistema Lagunare Veneziano".

REFERENCES

APPLEBY P. G. and OLDFIELD F., 1978. The calculation of lead-210 dates assuming a constant rate of supply of unsupported ^{210}Pb to the sediment. *Catena*, 5 : 1-8.

BATTISTON G. A., DEGETTO S., GERBASI R., SBRIGNADELLO G. and TOSITTI L., 1988. The use of ^{210}Pb and ^{137}Cs in the study of sediment pollution in the lagoon of Venice. *Sci. Tot. Env.*, 77 : 15-23.

McCAFFREY R. J. and THOMSON J., 1980. A record of the accumulation of sediment and trace metals in a Connecticut salt marsh *In* : Estuarine Physics and Chemistry: Studies in Long Island Sound. Adv. in Geophys., vol. 22 (B. Saltzman, ed.), pp. 129-164.

TUREKIAN K. K., NOZAKI Y. and BENNINGER L., 1977. Geochemistry of atmospheric radon and radon products. *Annual Rev. Earth Planet. Sci.*, 5 : 227-255.

MUSSEL WATCH : ASSESSMENT OF THE MARINE ENVIRONMENTAL QUALITY IN THE GULF OF TRIESTE (NORTHERN ADRIATIC SEA)

P. DEL NEGRO, L. MILANI, P. RAMANI, N. BURBA[1], S. FONDA UMANI[2]

[1] Marine Biology Laboratory, Trieste, Italy
[2] Department of Biology, University of Trieste, Italy

It is established that bioaccumulation in mussels adequately reflects the changing levels in the environment. for most contaminants. The degree of their accumulation by mussels depends on their filtering activity, growth, biochemical composition, reproductive condition and metabolism. These factors are in turn affected by environmental variables, such as temperature, salinity, dissolved organic matter and nutrients that influence the phytoplankton availability (WIDDOWS and DONKIN, 1992). The aim of this paper is to evaluate if faecal contamination of mussels reflects seawater contamination in different hydrochemical conditions.

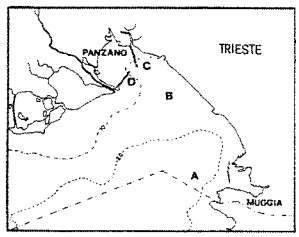


Fig. 1.Sampling stations in the Gulf of Trieste.

Starting from March 1991 until December 1992, a monitoring programme was carried out seasonally in four mussel farms located 200 m offshore in the Bay of Muggia (station A), along the coast of Trieste (station B) and in the Bay of Panzano (station C and D; Fig.1). For each station the physical structure of the water column was determined by using a CTD Idronaut Mod.401 multiparameter probe. Surface water samples were collected for the analysis of dissolved inorganic nutrients (GRASSHOFF *et al.*, 1983) and for the assessment of Total Coliforms (TC), Faecal Coliforms (FC) and Faecal Streptococci (FS) (APHA, AWWA, WPCF, 1989). The same bacteriological parameters were analysed in mussels randomly chosen from rearing ropes in each station. The hydrodynamism of the whole Gulf, stretching from the mouth of the Isonzo River (Bay of Panzano) to the Bay of Muggia, is mainly linked to the ascending eastern current flowing from the Istrian coasts, which carries higher salinity waters from the Middle Adriatic into the northern basin. Lower density and lower salinity freshwater coming from rivers, mainly the Isonzo and the Timavo, and urban wastes tend to flow on the surface (DEL NEGRO *et al.*, 1993). The river inputs are particularly evident in stations C and D, characterized by lower salinity and higher temperature values, whereas the eastern current is mainly perceived in stations A and B, characterized by higher salinity values. The results of faecal contaminants presence in seawater are reported in Table I.

St.	Spring A '91	Spring A '92	Spring B '91	Spring B '92	Spring C '91	Spring C '92	Spring D '91	Spring D '92	Summer A '91	Summer A '92	Summer B '91	Summer B '92	Summer C '91	Summer C '92	Summer D '91	Summer D '92
TC	2	17	0	172	141	542	130	278	49	13	23	23	49	23	0	23
FC	2	2	0	11	79	49	130	7	49	9	5	5	22	0	0	0
FS	2	0	0	2	21	0	1100	0	0	6	6	2	2	0	0	5

St.	Autumn A '91	Autumn A '92	Autumn B '91	Autumn B '92	Autumn C '91	Autumn C '92	Autumn D '91	Autumn D '92	Winter A '91	Winter A '92	Winter B '91	Winter B '92	Winter C '91	Winter C '92	Winter D '91	Winter D '92
TC	22	17	7	23	918	1609	130	79	49	542	11	70	1609	1609	918	1609
FC	5	0	0	0	9	33	2	17	13	348	0	5	33	45	27	278
FS	0	0	4	0	109	5	26	0	5	17	0	2	0	221	13	130

Table I. Presence of Faecal Pollution Indicators in sea water (MPN.100cm^{-3})

According to cluster analysis two groups of stations were identified : A and B, C and D. The highest values of Coliforms and Streptococci were observed in stations C and D clearly due to urban and industrial wastes flowing in the area and to the river inputs that receive wastes both in Italy and Slovenja. In Stations A and B the pollution was mainly due to diluted urban waste. During 1992 an increase of TC values was observed in all the stations, particulary in spring and winter, while Streptococci generally decrease. No difference between stations appeared with bacteriological analysis of the mussels (Table II). In autumn and winter FC:FS ratio is always low (under 0.7 value) according to high Streptococci values. Unlike water situation, generally the uptake of faecal bacteria by mussels was greater in 1991 than 1992, particularly Coliform values decreased in the last year.

St.	Spring A '91	Spring A '92	Spring B '91	Spring B '92	Spring C '91	Spring C '92	Spring D '91	Spring D '92	Summer A '91	Summer A '92	Summer B '91	Summer B '92	Summer C '91	Summer C '92	Summer D '91	Summer D '92
TC	1100	240	1100	150	1100	240	240	460	1100	9	1100	15	1100	11	1100	93
FC	75	15	290	0	120	23	4	15	24	0	290	0	19	7	1100	0
FS	75	29	6	93	43	93	240	93	1100	150	150	1100	150	1100	150	11

St.	Autumn A '91	Autumn A '92	Autumn B '91	Autumn B '92	Autumn C '91	Autumn C '92	Autumn D '91	Autumn D '92	Winter A '91	Winter A '92	Winter B '91	Winter B '92	Winter C '91	Winter C '92	Winter D '91	Winter D '92
TC	1100	120	1100	210	1100	1100	1100	150	460	1100	1100	1100	1100	1100	1100	1100
FC	15	75	4	4	75	7	4	28	240	23	6	4	278	0	39	23
FS	1100	1100	43	1100	1100	240	1100	1100	15	53	1100	1100	0	0	34	1100

Table II. Presence of Faecal Pollution Indicators in mussels (MPN.100cm^{-3})

The trend of Total Inorganic Nitrogen (TIN) and P-PO_4 confirms the identification of two aforementioned groups of stations : C and D generally present the highest values. In spring and winter 1992 TIN values were higher than 1991. This is in agreement with the water FC trend and it is probably due to intense rainfall in the area. In conclusions, no relationship was found between water and mussels faecal contamination. A possible explaination may be the different sampling method : the water was collected from the surface, while the mussels were taken at various depths. Another factor well known is the integrated response that mussels provide to the "total pollutant load" (WIDDOWS and DONKIN, 1992). For this reason, the concept of "mussel watch", largely considered as more confident than few analyses in the water, may only be used for the assessment of sea water faecal pollution when knowing the influence of environmental variables on mussels metabolism.

REFERENCES

APHA, AWWA, WPCF, 1989. Standard methods for examination of water and wastewater. 17th ed.

DEL NEGRO P., MILANI L., SANZIN F., BURBA N., FONDA UMANI S., 1993. Production, Environment and Quality. Barnabè & Kestemont. Eds., E.A.S. Special Publ. 18, Belgium : 569-577.

GRASSHOFF K., EHRHARDT M., KREMLING K., 1983. Methods of seawater analysis. Verlag Chemie. Weinheim (Germany) : 419

WIDDOWS J., DONKIN P.,1992. The mussel *Mytilus:* ecology, physiology, genetics and culture. Gosling E. Ed. Elsevier, 383-424.

TRANSPORT DU PLOMB ATMOSPHÉRIQUE EN MÉDITERRANÉE OCCIDENTALE ET STOCKAGE DE CE MÉTAL DANS LES SÉDIMENTS D'UNE ZONE PROFONDE

F. FERNEX[1], C. MIGON [2], G. FEVRIER[3], A. ARNOUX[4]

[1] Lab. de Géochimie isotopique, U.A. CNRS "Géosciences de l'Environnement", Fac. des Sciences, Parc Valrose, 06108 Nice, France
[2] Lab. de Physique et Chimie marines, Observatoire Océanologique, 06230 Villefranche/Mer, et Université de Corse, Corte, France
[3] Lab de Chimie des Organo-métalliques, Univ. de Toulon et du Var, La Garde, France
[4] Lab de Molismologie Aquatique, Fac. de Pharmacie, Univ. Marseille, France

Au moins jusqu'en 1990, la plus grande partie du Pb apporté à la mer Méditerranée l'a été directement par voie atmosphérique, et la plus grande partie de la contamination de la mer par ce métal est due à son addition à l'essence utilisée par les voitures. Nous avons collecté de façon continue le Pb atmosphérique en une station située au Cap Ferrat (France) en 1986-1987. Ce site est très peu influencé par les émissions de Pb dues à la circulation dans les villes voisines (Nice s'étend à 6 ou 7 km à l'W du site étudié). D'après les mesures effectuées sur les échantillons prélevés en ce point en 1986 et 1987, l'apport annuel moyen sur l'ensemble de la Méditerranée occidentale est de 4080 t /an. Cette valeur englobe le Pb atmosphérique tant naturel que d'origine anthropique. D'après des mesures réalisées sur des échantillons du Cap Ferrat, 91% du Pb atmosphérique a une origine anthropique (MIGON et CACCIA, 1990).

On peut supposer que le flux de Pb atmosphérique d'origine anthropique a varié au cours du temps de façon proportionnelle à la consommation du Pb mélangé à l'essence. La quantité de Pb introduit chaque année dans l'essence par les entreprises pétrolières est connue. Le maximum de consommation en France a eu lieu en 1976, avec 14 500 t Pb/an. En considérant la période de 1950 à 1987, la contamination annuelle moyenne sur l'ensemble de la Méditerranée occidentale a été de 3360 t, soit 3.95 kg km^{-2} /an.

Une fois arrivé à la mer, ce Pb semble rapidemment assimilé par le phytoplancton (ROMEO *et al.*, 1988). En produisant des pelotes fécales, le zooplancton herbivore permet le transfert d'une grande partie du Pb vers les sédiments du fond. Très vite après son incorporation aux sédiments superficiels, une grande part du Pb subit l'influence de la diagenèse (SCOULLOS, 1986). Pour une grande part libéré de la phase particulaire, il enrichit les eaux interstitielles qui de la sorte (et bien qu'elles ne soient pas saturées) sont plus riches en Pb dissous que l'eau de mer sus-jacente. Ainsi, un flux "de retour" s'établit des sédiments vers l'eau de mer, où le phytoplancton est de nouveau susceptible d'assimiler le métal.

Cependant dans une zone profonde de la Méditerranée occidentale d'environ 30 000 km^2, les sédiments superficiels contiennent des concentrations en oxydes de Manganèse (et de Fe) très nettement plus élevées que dans les niveaux sous-jacents (Fig. 1), et que dans les sédiments des régions voisines. Il y a donc eu concentration en Mn dans les sédiments superficiels de cette zone profonde. Dans cette même zone, les concentrations en Pb (et en Cu) sont aussi relativement élevées. Lors de la précipitation des oxides de Mn, des métaux dissous en trace dans les eaux interstitielles ont pu co-précipiter avec le Mn à condition que leur concentration soit proche de la saturation (dans les conditions de pH et d'oxido-réduction régnant dans le milieu). Tel est bien le cas dans cette zone, alors que le Mn se trouve dans les eaux des sédiments superficiels en légère sursaturation par rapport à son oxyde le moins soluble.

On constate que dans les niveaux sédimentaires supérieurs (0-6 cm), les concentrations en Pb sont plus élevées qu'en dessous. Le Pb "en excès", c'est-à-dire le Pb dont les concentrations dépassent celles des niveaux plus profonds, est extractible au moyen d'attaques chimiques ménagées (solution acétique à pH 5, solutions d'hydroxylamine, de dithionite (=hydrosulfite)). On peut estimer que, en moyenne, de 800 à 1080 t de Pb d'origine anthropique ont été stockées chaque année depuis 1950.

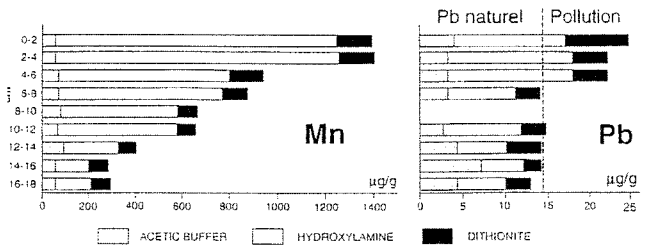


Fig. 1 - Zone profonde où les concentrations en Mn et en Pb sont relativement élevées dans les sédiments superficiels. Profils de la quantité de Mn et de Pb extraits au moyen de réactifs modérés en procédant de façon séquentielle : 1/ attaque acétique, pH 5; 2/ lessivage au moyen d'une solution d'hydroxylamine (pH 3); 3/ dithionite (= hydrosulfite). Les concentrations en Mn sont très faibles en profondeur; cela suggère une mise en solution et une migration vers les niveaux supérieurs, oxydants où le Mn dissous tend à précipiter sous forme d'oxydes.

L'apport "direct" de Pb atmosphérique (naturel et anthropique) sur les 80 000 km^2 de la zone considérée est de 316 t /an. Une grande partie est évacuée hors du bassin occidental par le détroit de Gibraltar et surtout le détroit sicilo-tunisien. Les concentrations en Pb des eaux de mer en provenance de la Méditerranée orientale ont nettement plus faibles que celles qui s'écoulent du bassin occidental vers la Méditerranée orientale. En tenant compte de la perte au niveau des détroits, l'apport direct" vers le fond de la zone profonde (80 000 km^2) a été, en moyenne, de 184 t /an. Or nous avons estimé que 800 à 1080 t de Pb d'origine anthropique étaient en moyenne stockées chaque année dans les sédiments de cette zone. Le surplus est (800 à 1080) - 184 = (616 à 896) t /an.

Ce surplus correspond surement a un flux "indirect" de Pb vers les sédiments de cette même zone : il s'agit de Pb qui, après avoir sédimenté dans les zones voisines, a été libéré au cours de la diagenèse et relargué vers l'eau de mer, puis à nouveau entraîné vers le fond au moyen de pelotes fécales.

RÉFÉRENCES

MIGON C., CACCIA J.L., 1990. *Atmosph. Environm.*, 24 A : 399-405.
ROMEO M., GNASSIA-BARELLI M., NICOLAS E., CARRE C., 1988. *Rapp. Comm. int. Mer Méditerr.*, 31(2) : 35.
SCOULLOS M., 1986. *Sc. of Total Environm.*, 49 : 199-219.

MUSSELS AS INDICATOR OF ORGANOCHLORINE POLLUTION IN A MAN-AFFECTED GULF (SARONIKOS GULF, HELLAS)

E. GEORGAKOPOULOU-GREGORIADOU, R. PSYLLIDOU-GIOURANOVITS, F. VOUTSINOU-TALIADOURI and V.A. CATSIKI

National Centre for Marine Research, 166 04 Hellenikon, Hellas

Chlorinated insecticides and polychlorinated biphenyls are among the most persistant and toxic pollutants in aquatic and terrestrial ecosystems, because of their stability and bioaccumulative capacity. Although their use has been restricted or discontinued in recent years, their residues remain in the environment for a long time and continue to pose problems (TANABE, 1988). Mussels are considered as an appropriate indicator for organisms showing chlorinated hydrocarbon contamination derived from local sources. This is due to their sedentary and filter feeding habit (National Academy of Sciences, 1980).

The study area is the Saronikos Gulf, a typical semi-enclosed basin, that receives the sewage of urban activities and the industrial discharges of the Greater Athens Metropolitan area. During the 1988-91 period mussels (*Mytilus galloprovincialis*) have been collected from three coastal stations A, B, C (fig. 1), by scuba diving from a depth 1 to 3 m. Samples consisted of 30 individual animals with shells 3-5.5 cm long. Soft tissue was removed from shell and after lyophilization and grinding a subsample was extracted with n-hexane. The cleaning-up and fractionation took place on alumina columns and the fractions were measured on a GC with ECD Ni 63 and Megabore column 30 m long, (SATSMADJIS *et al.*, 1988). The organochlorines analysed were : PCBs (Aroclor 1254, Aroclor 1260), DDT and its metabolites (DDE, DDD), HCHs (α, γ) and Dieldrin. The lipids content was also determined in an aliquot of the extrate.

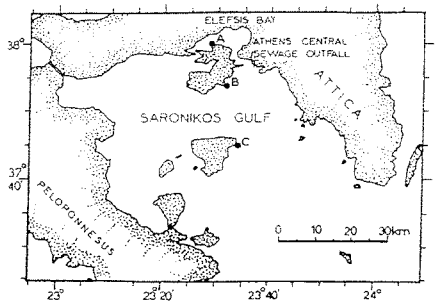


Fig. 1 : Sampling locations in the Saronikos Gulf

The analysis of the data reveals that the major pollutants are PCBs, ranged from 42.3 to 383.9 ng/g dry weight. DDTs concentrations vary between 7.3 and 142.0 ng/g dry wt. while the HCHs and Dieldrin levels are relatively low (Table 1).

Table 1: Concentrations (ng/g dry wt.) of organochlorine residue in mussels (*Mytilus galloprovincialis*) from Saronikos Gulf (Athens, Hellas) during the 1988-91 period.

St	PCBs		DDTs		HCHs		Dieldrin	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
A	211	88.5-383.9	25.3	11-44.5	5.3	3.1-11.9	2.7	1.1-5.5
B	153.9	94.9-216.9	37.0	18.4-142.0	5.4	2.4-21.2	3.2	0.5-8.9
C	85.6	42.3-122.0	16.9	7.3-25.3	8.0	4.6-17.9	3.5	1.8-6.1

In all samples Aroclor 1254 is found in higher concentrations than Aroclor 1260. The pattern of abundance of the DDT group of compounds is DDE>DDD>DDT (ICES, 1974), while the γ isomer predominates in relation to α in the HCHs isomers. The ratio PCBs/DDTs is higher than 1 (in all stations), suggesting that the industrial activities are greater than agricultural ones in this region (PICER *et al.*, 1978). Figures 2 and 3 are showing the annual distribution of PCBs and DDTs in the study area.

Generally, we can say that the concentrations of organochlorine compounds determined in this study, are lower than the ones reported for other Mediterranean coastal areas (Med. Action Plan, 1990) and below the health hazard limits.

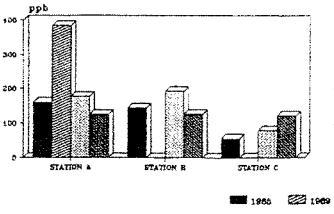


Fig. 2 : Annual distribution of PCBs

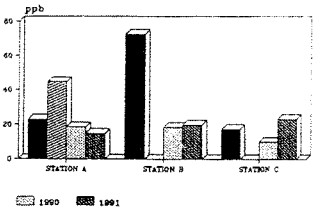


Fig. 3 : Annual distribution of DDTs

REFERENCES

ICES, 1974. Report of working group for the International Study of the Pollution of the North Sea and its effectes on living resources and their exploitation. Cooperative Report Res. Serial n°39 : 191.
MEDITERRANEAN ACTION PLAN (MED POL), 1990. Assesment of the state of pollution of the Mediterranean Sea by organohalogen compound. *Technical Reports Series*, n°39.
NATIONAL ACADEMY OF SCIENCES, 1980. The International mussel watch. Report of a workshop sponsored by the Environmental Studies Board Commission on Natural Resources. National Research Council, Washington D.C., pp. 163-235.
PICER, M., PICER, N. and AHEL, M., 1978. Chlorinated Insecticide and PCB Residues in Fish and Mussels of East Coastal Waters of the Middle and North Adriatic Sea, 1974-75. *Pesticides Monitoring Journal*, 12 : 102-112.
SATSMADJIS, J., GEORGAKOPOULOU-GREGORIADOU, E. and VOUTSINOU-TALIADOURI, F., 1988. Separation of chlorinated hydrocarbons on alumina. *J. Chromatography*, 437 : 254-259.
TANABE, S., 1988. Problems in the future. Foresight from current knowledge. *Environ. Pollut.*, 50 : 5-29.

L

SEASONAL VARIATIONS OF METALS IN ZOOPLANKTON IN THE COASTAL WATERS OF THE SOUTH ADRIATIC SEA

E. HAJDERI[1], M. M. STORELLI[2], G. DE NATALE[2], G. O. MARCOTRIGIANO[2]

[1] Fakulteti i Shkencave Natyrore, Universiteti i Tiranes, Tirana, Albania
[2] Istituto di Chimica, Facoltà di Medicina Veterinaria, Università di Bari, Bari, Italia

In various studies it has been demonstrated that the zooplankton is responsible for removal and transport processes of trace metals from the oceanic surface layers to the sediments due to its ability to accumulate the metals in relatively high quantities (MARTIN & KNAUER, 1973; CHESTER & ASTON, 1976).

The data reported concerned the seasonal variations of some metal concentrations in zooplankton collected along the coast of Apulia in the months of June, October, December 1993 and February, April and May 1994. The samples were collected out of the port of Bari along a transect situated at 2 km from the coast. The zooplankton was sampled in horizontal hauls with a "Bongo 20" net with 235 µm mesh size. In the last three months, samples of waters, sardine (*Sardina pilchardus*) and mackerel (*Scomber scombrus*) specimens were also collected.

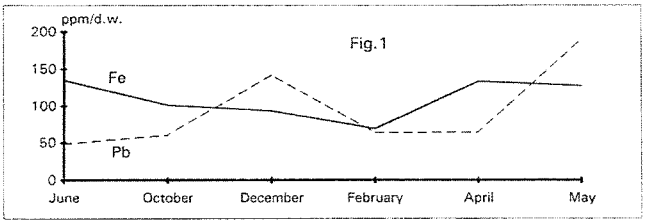
The zooplankton samples were filtered and dried and then the quantitative determination of metals was calculated by spectrophotometry in A.A. after organic matrix disgregation. The same chemical procedure was used to determine the metals in the dorsal muscle of the fishes, while the metals from the sea water samples were quantitatively extracted by solid phase extraction using SPE-phenyl for Hg, Cd, Pb, Cu, Fe, Ni and SPE-amino for Cr. The analytical data obtained show evident seasonal variations in the quantities of most metals found in the zooplankton. Pb and Fe had the highest concentration (tab.1). Pb levels were particularly high in December (142 ppm/d.w.) and May (190 ppm/d.w.) (fig.1) and comparable to those found in polluted areas of the North Adriatic Sea (CRISETIG *et al.*, 1984). These values are particularly elevated compared to metal levels found in the waters and fish samples. The highest concentrations of Fe were obtained in late spring and summer (134 ppm/d.w.).

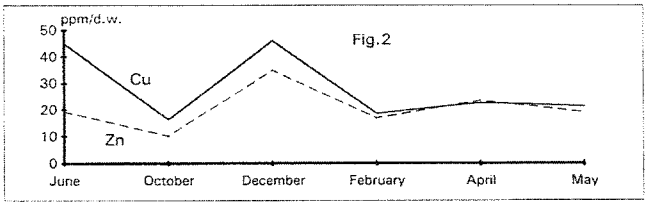
The levels of Cu and Zn throughout the seasons are very similar (fig.2). The highest concentrations of Zn were observed in December while for Cu in June and December. A certain correlation can be seen, however it does not reach significative levels ($P > 0,1$). This correlation has not been observed in other coastal areas of West Mediterranean where the levels for these metals in zooplankton are even higher (HARDSTEDT & LUMOND, 1980). The Cd levels, which present two peaks in June (8,77 ppm/d.w.) and April (6,23 ppm/d.w.), are comparable to those found in polluted waters of the North Adriatic Sea. For Hg, whose highest levels are observed in December (fig.3), concentrations have similar levels to those found in coastal waters of the Middle Adriatic Sea (CRISETIG *et al.*, 1982). Sn and Se reach higher levels in the summer-spring period. As concerns the levels of metals in sea water, the highest values were observed for Sn (max.9,8 µg/l) and Fe (4,5 µg/l).

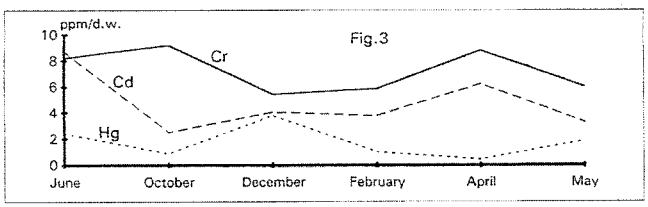
In the fishes, the concentrations of Cr, Cd, Cu and Ni were slightly higher in the sardines whereas in the mackerels higher levels were observed for Zn, Hg, Fe, Sn, As and Se. The greatest difference was found for Zn.

Metals	Pb	Cr	Cd	Cu	Zn	Hg	Fe	Sn	As	Se	Ni
sea water	1,18	0,14	0,15	0,86	-	0,13	2,93	6,36	-	-	0,54
zooplankton	94,95	7,24	4,77	28,32	20,63	1,74	109,91	18,20	7,45	14,67	20,03
S. pilchardus	2,79	1,45	0,75	7,16	0,59	1,07	19,96	6,56	5,81	3,56	0,17
S. scombrus	2,72	1,12	0,50	5,15	1,24	1,50	20,97	6,70	8,35	5,12	0,11

Table 1. Average values of metal concentrations in seawater (µg/l), zooplankton and fishes (ppm/dry weight)







REFERENCES

CHESTER R & ASTON S.R., 1976. *Chemical Oceanography*, Academic, New York : 281-390.
CRISETIG C., CATTANI O., MASSA D., POLLETI R., 1982. *Boll. Soc. It. Biol. Sper.*, 58 1085-1092.
CRISETIG C., CATTANI O., FONDA-UMANI S., SERRAZANETTI G. P.,VIVIANI R., 1984. *Nova Thalassia*, 6 : 85-93.
HARDSTEDT-ROMEO M. & LUMOND F., 1980. *Mar. Pollut. Bull.*, 11 : 113-138.
MARTIN J. H. & KNAUER G. A., 1973. *Geochim. Cosmochim. Acta*, 37 : 1653-1693.

TRACE METALS CONTAMINATION IN SEDIMENTS FROM THE KISHON RIVER, ITS DRAINAGE BASIN AND ESTUARY, MEDITERRANEAN COAST OF ISRAEL

Barak HERUT[1], Moshe SHIRAV[2], Nurit KRESS[1] and Hava HORNUNG[1]

[1] The National Institute of Oceanography, Israel Oceanographic and Limnological Research, Tel Shikmona, P.O. Box 8030, Haifa 31080, Israel
[2] Geological Survey of Israel, Jerusalem 95501, Israel

The Kishon river, which empties into the Haifa Bay is regarded as the most polluted coastal river in Israel. The river runs through the largest industrial area in the country and is subjected to considerable inputs of organic and trace metal contaminants from oil refineries, petrochemical and fertilizer plants, a sewage treatment plant, intensive agriculture in the recharge area and other sources (COHEN *et al.*, 1993; KRUMGALZ *et al.*, 1990). Except during rainy winters (particularly such as 1991/92), the flow along the lower river system is dominated by the effluents from industries and the sewage treatment plant.

Surficial sediment samples (~ 3 cm top layer) from the Kishon river, its drainage basin (stream sediments), harbors and estuary were collected by grab or with a plastic scoop. Trace element concentrations in the samples were analyzed according to HERUT *et al.* (1993). The sampling was carried out once after the winter and again after the summer. The metal concentrations were normalized by Al as a conservative element in order to minimize grain size variations. Sediments from the upper river system and its drainage basin showed relatively low metal/Al ratios while high peaks of the polluted trace metals were recorded along the entire lower river system (Fig. 1). These normalized ratios decrease in the estuary sediments, from the Fishing Harbor seaward. For elements derived mainly from natural environment, such as Fe, Ce, Mn and Eu, no major differences were detected along the entire Kishon - Haifa Bay complex. Although contaminants are trapped in the sediments of the lower Kishon river system, river-borne contamination was also evident in the southern part of Haifa Bay deriving from bottom transport of sediment particles, suspended matter and disposal at sea of dredge spoils from the river harbors.

The interrelations between trace, minor and major elements in the Kishon system reveal the existance of two main situations : (1) during the winter, when relatively clean sediments from the drainage basin are contaminated in the lower river system by trace metals contained in industrial effluents, and close to the harbors area where the organic matter plays a major role in the accumulation of part of these metals; (2) during the summer, when due to low energy conditions, most trace metals sink directly and via scavenging by organic matter along the entire lower river system. Thus, the scavenging of trace metals from the Kishon waters seems to be controlled by two main factors : (a) the amount of organic matter input and (b) the hydrological regime of the river.

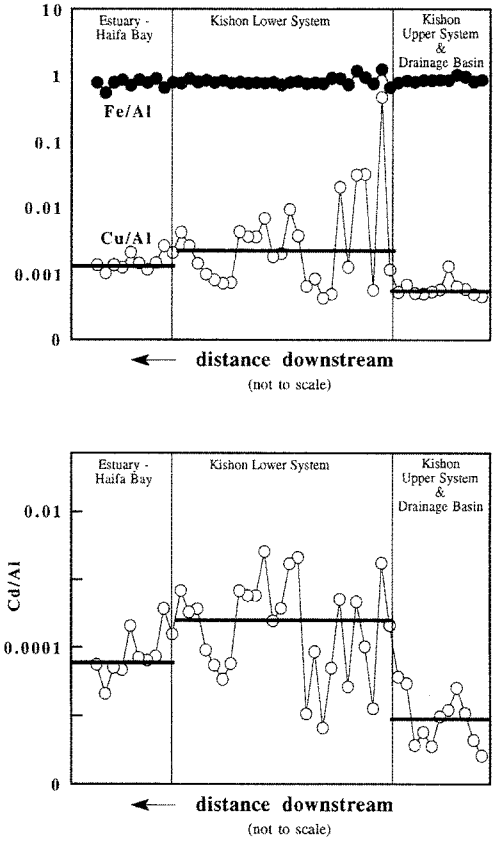


Fig. 1: Selected metals/Al ratios (wt./wt.) along the entire Kishon system. Horizontal lines represent the median values in each sub-system.

REFERENCES

COHEN Y., KRESS N. and HORNUNG H., 1993. Organic and trace metal pollution in the sediments of the Kishon river (Israel) and possible influence on the marine environment. *Wat. Sci. Tech.*, 27 : 439-447.
HERUT B., SHIRAV M., KRESS N., HORNUNG H., OLGA Y. and ILLANI S., 1993. Geochemistry of the Kishon Basin sediments, trace metals and organic matter behavior. IOLR Rep., H25/93, 70 pp.
KRUMGALZ B.S., FAINSHTEIN G., GORFUNKEL L. and NATHAN Y., 1990. Fluorite in recent sediments as a trap for trace metal contaminants in an estuarine environment. *Estuary Coastal and Shelf Sciences*, 30 : 1-15.

ASSESSMENT OF MARINE COASTAL EUTROPHICATION BASED ON SCALING NITRATE CONCENTRATIONS

M. KARYDIS

Department of Environmental Studies, Universtity of the Aegean, Mytilini, Greece

The quantitative assessment of eutrophication still remains a problem in spite of the research that has been carried out over the last decades (LIKENS, 1972). Nutrient concentrations are often used in assessing trophic levels (KARYDIS *et al.*, 1983); however, there are problems related to the data analysis since nutrient values deviate from normality and big overlaps between data sets characterising oligotrophic, mesotrophic and eutrophic conditions are observed (IGNATIADES *et al.* 1992). In the present work these shortcomings on the data analysis have been considered and a distribution-free statistical procedure based on scaling nitrate concentrations is proposed as a methodological tool for quantitative assessment of the trophic conditions in marine coastal systems.

Nitrate concentrations from a eutrophic, a mesotrophic and an oligotrophic area, characteristic of Eastern Mediterranean waters (IGNATIADES *et al.* 1992) formed the basis of the scaling system for assessing eutrophication. Each data set was divided into quartiles and in this way a scoring system was developed. Nutrient values ranging from zero to the minimum value of the data set were assigned by the ordinal number 0, between the min. value and lower quartile (LQ) by 1, between LQ and median (M) by 2, between M and the upper quartile (UQ) by 3, between UQ and max. by 4 and finally nitrate concentration values exceeding the max. value of the data set were assigned by the ordinal number 5 (Fig. 1a).

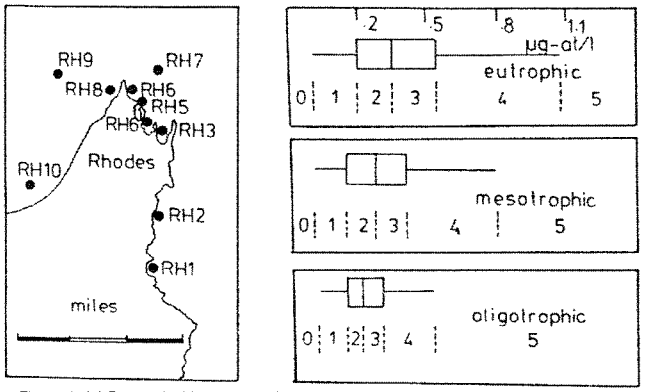


Figure 1. (a) Box-and-whisker plots of the three standard data sets and the ordinal scale described in the text. (b) Station locations

The sum of the scores from the three standard data sets of each data point representing a sampling site an estimate of the trophic level for that particular sampling site. Ten stations (Fig. 1b) spaced along the coastal area of Rhodes, Greece, were used to evaluate the effectiveness of the proposed procedure. It has been found (KARYDIS, 1992) that stations 3, 4 & 5 were eutrophic, 7 & 9 oligotrophic and the remaining sampling sites were mesotrophic. Mean annual values of nitrate concentrations were calculated and their scoring was recorded (Tab. 1)

	RH1	RH2	RH3	RH4	RH5	RH6	RH7	RH8	RH9	RH10
Raw values	0.68	0.45	2.51	6.25	3.00	0.60	0.35	0.42	0.28	0.51
NO3 scaling	13	11	15	15	15	13	9	11	7	11

Table 1 Mean annual values of nitrate concentrations along the coastal area in Rhodes, Greece. Second line of the table: scorine of the trophic leves based on the proposed scaling system

The numerical classification of the ten sampling sites is given in Fig. 2. It was observed that the stations were grouped into eutrophic (3, 4, 5), oligotrophic (7, 9) and mesotrophic (1, 2, 6, 8, 10) states. This grouping was far more pronounced and clear-cut using the results from the scoring system (Fig. 2b) compared to the log transformed raw values (Fig. 2a). This grouping was also statistically confirmed by ANOSIM a non-parametric permutation test (CLARKE, 1993). Further work is being carried out on a number of variables characterizing eutrophication.

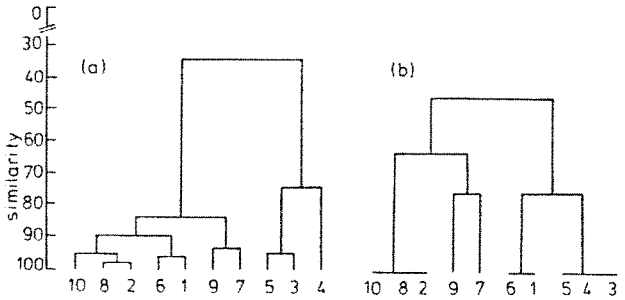


Figure 2. (a) Tree-diagram of the stations based on logtransformed raw values. (b) Tree-diagram of the stations based on the scaling system developed

REFERENCES

CLARKE K.R., 1993. Non-parametric multivariate analyses of changes in community structure. *Australian Journal of Ecology*. 18 : 117-143.

IGNATIADES L., KARYDIS M. and P. VOUNATSOU, 1992. A possible method for evaluating oligotrophy and eutrophication based on nutrient concentration scales. *Mar. Poll. Bull.*, 24 : 238-243

KARYDIS M., IGNATIADES L. and MOSCHOPOULOU N., 1983. An index associated with nutrient eutrophication in the marine environment. *Estuar. Coast. Shelf Sci.*, 16 : 339-344

KARYDIS M., 1992. Scaling methods in assessing environmental quality: a methodological approach to eutrophication. *Environmental Monitoring & Assessment*, 22 : 123-136

LIKENS G., 1972. Eutrophication and aquatic ecosystem : Nutrient and eutrophication. The American Society of Limnology and Ocenography, Special Symposia, Volume I.

UPTAKE OF CADMIUM FROM WATER AND FOOD IN *MUREX TRUNCULUS*

G. LORENZINI, E. ORLANDO

Dipartimento di Biomedicina Sperimentale, via A. Volta 4, 56126 Pisa, Italia

A previous study aimed to determine Cd concentration in *Murex trunculus* from different areas of North Tyrrhenian coast showed that, also in unpolluted marine waters, this gastropod can reach a high concentration of this metal.

In some marine areas of this coast, Cd is found only in *Murex* and not in other species (*Donax, Venus, Mactra* and *Mytilus*) living in the same environment. Data on Cd levels in *Murex* were obtained by atomic absorption spectrophotometric methods (IL S11 spectrophotometer equipped with a deuterium lamp). The soft parts of *Murex* were first digested overnight in cold 65% nitric acid (Merck Suprapur) and subsequently in boiling acid in distillation vessels. The values of Cd concentrations are expressed in ppm dry weight. Reference standards of lobster hepatopancreas (National Research Council, Canada) were also processed in order to check the analytical accuracy. All the standards gave values inside the 95% range of the mean certified value.

The analytical data, in agreement with other authors (BOUQUEGNEAU, 1988), showed that the digestive gland is the target organ for Cd. From our data, this organ represents about 80% of the total metal body burden whereas a contribution of 2,5% is due to the gills. In order to get a further insigth to the ways Cd is accumulated in *Murex*, two experiments were carried out in the laboratory.

In a first experiment, 16 animals were exposed to 150 µg/l of Cd administered as nitrate in seawater. In a second experiment, 20 animals were fed with mussels previously contaminated through a 6 weeks exposure to 150 µg/l of Cd in seawater. Every animal was fed with one mussel and received a load of about 50 µg of the metal.

In the *Murex* of the first experiment, a fast increase of Cd was observed in the gills whereas in the digestive gland, after 14 days of Cd exposition, the concentration of this metal was not significantly different from uncontaminated animals (Fig.1-2).

The data of the second experiment showed that at the 8th week after predation, the levels of Cd in the digestive gland were yet 10 times higher than the values measured in the controls. Moreover, this time, the loss of the metal from the digestive gland seems very slow. The gills showed an increase with a maximum value at the 3th week after predation to decrease subsequently. Cd accumulation in the gills is probably linked to the transfer of the metal from the digestive gland by the blood.

Therefore the digestive gland of *Murex* seems to take high load of Cd only when present in the food and not when the metal is present in dissolved form in seawater. Cd consumed with the food, on the other hand, is lost speedly by the digestive gland in the first weeks but subsequently the excretion, in agreement with data on other molluscs (VIARENGO, 1989), is very slow. This seems to indicate that the diet is the more important source of cadmium for *Murex trunculus*. An histological study was performed on the digestive gland in order to observe alterations at the subcellular level due to this toxic.

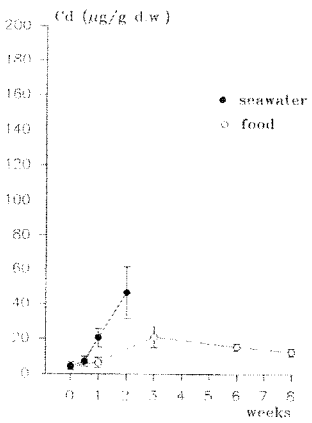


Fig.1. Cd in the gill of *Murex* exposed to contamined sea water or food

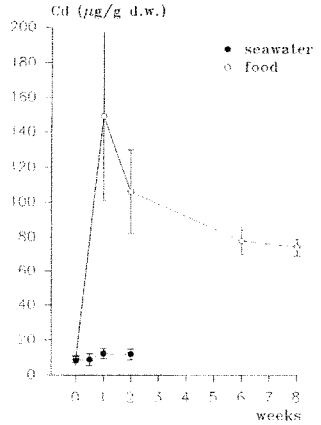


fig.2. Cd in deigestive gland of *Murex* exposed to contamined sea water or food

REFERENCES

BOUQUEGNEAU J.M., CANON C., MARTOJA M. 1988. Nouvelles données sur la teneur en cadmium de *Murex trunculus* (gasteropode prosobranche) en milieu naturel non pollué. *Océanis*, 14 (4) : 447-451.

VIARENGO A. 1989. Heavy metals in marine invertebrate s: mechanisms of regulation and toxicity at the cellular level. C.R.C. *Critical Rewiews in Aquatic Sciences*. 1 (2) : 295-317.

L

DETECTING LOW-LEVEL SEWAGE POLLUTION USING ROCKY SHORE COMMUNITIES AS BIO-INDICATORS

Adrian MALLIA & Patrick J. SCHEMBRI

Department of Biology, University of Malta, Msida, Malta.

While coastal pollution due to high inputs of organic matter is easy to detect and monitor, this is much more difficult in the case of sporadic low-level inputs. Moreover, routine water-quality surveys of large stretches of coastline are time-consuming and often prohibitively expensive. Such monitoring is therefore usually limited to sensitive areas. These restrictions make the results less useful for purposes of coastal pollution management. The indirect assessment of the degree of pollution is thus very appealling (SATSMADJIS, 1985), more so when one can use inexpensive equipment and perennially present indicators. Rocky shore community structure has the potential of being a very suitable indicator of coastal low-level organic pollution: it represents the integrated response of the shore biota to environmental perturbations over time and such communities are readily accessible from the land. The present study evaluates the suitability of using rocky shore community structure as such an indicator in the Maltese Islands. The rocky shore communities at Xghajra, located 1.3 km south of Malta's main sewage outfall and down-current from it, and those at four control sites north of the outfall (Fig.1), were sampled quantitatively by means of 0.5 m x 0.05 m contiguous quadrats along belt transects set perpendicular to the shoreline. Six transects were sampled at Xghajra and one each at the control sites. Faunal species were recorded as number of individuals per unit area and the algae as percentage cover. The data were subjected to a hierarchical cluster analysis using centroid linkage and the Bray-Curtis similarity coefficient for the quantitative data, and the Jaccard coefficient and centroid linkage for the presence/absence data (DIXON, 1988). This was done to correlate the groupings formed with environmental factors.

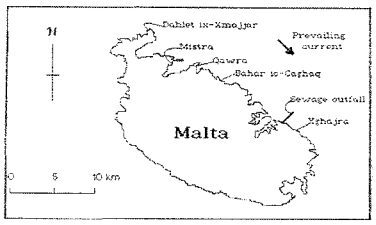


Fig 1. The Maltese islands : the location of Xghajra and the 4 control sites relative to the sewage outfall.

These statistical analyses gave similar results for all the transects, irrespective of the site. Quadrats from each transect were clustered into three distinct groups. The first group contained all the algae and most of the lower shore animals (including *Lepidochitona corrugata, Patella ulyssiponensis, Patella caerulea, Dendropoma petraeum*, etc.). This corresponds to the lower mediolittoral zone of PÉRÈS & PICARD (1964). The second group contained the barnacle *Chthamalus stellatus*, sometimes alone but more often together with one or more other species, such as *Littorina neritoides, Patella rustica, Monodonta turbinata, coralline algae, cyanobacteria* or terrestrial lichens. This corresponds to PÉRÈS & PICARD's upper mediolittoral zone. The third and last group, corresponding to the supralittoral zone of PÉRÈS & PICARD, was composed of the upper shore quadrats with the gastropod *L. neritoides* either alone, as at Xghajra, or together with one or both of the barnacles *C. stellatus* and *C. depressus*. However, Xghajra differed from the control sites in having a higher species richness (Table 1), and a different suite of species (Fig. 2). In particular, Xghajra differed in having a near total absence of the *Cystoseira* cover found on other rocky shores in the Maltese Islands, with only a few stunted specimens of *C. stricta* and *C. compressa* recorded; the absence of species intolerant to pollution (e.g. *Padina pavonica, Acetabularia acetabulum*); and the presence of a large number of pollution-tolerant species (e.g. *Pterocladia capillacea, Corallina elongata, Gigartina acicularis, Ulva rigida, Enteromorpha* spp. and *Cladophora* spp.)

Thus, while the general zonation patterns at Xghajra were similar to those of the four control sites, the shore community here exhibited some peculiarities when compared to the rest, especially in the type of species present and in their abundance. The dominant algae at Xghajra formed associations characteristic of environments having high organic loading in the water as shown in other parts of the Mediterranean and the Red Sea (CORMACI *et al.*, 1985; D'ANNA *et al.*, 1985; ISMAIL & AWAD, 1987; CORMACI & FURNARI, 1991). The presence at Xghajra of a large population of *Mytilaster minimus*, a well known indicator of high nutrient levels (D'ANNA *et al.*, 1985), is indicative of high levels of nutrients in this locality. The chemical analyses carried out in this region confirm this (CHIRCOP, 1992). The type of species, the species richness, their abundance, as well as their associations (especially those exhibited by the algae), at Xghajra, are unusual for Maltese rocky shores and to date have only been found in this area. These results suggest that rocky shore biotic assemblages may be useful indicators of low-level sewage pollution, at least under local conditions.

Location	species richness	algae	animals
Xghajra	65	36	29
Bahar-Ic-Caghaq	21	11	10
Qwara	27	16	11
Mistra	33	22	11
Dahlet-Ix-Xmajjar	32	16	16

Table 1. Comparison of the species richness at Xghajra and the 4 control sites

REFERENCES:

CHIRCOP, P. (1992). An investigation on the sewage outfall at Wied Ghammieq. Unpubl. B.Sc Dissertation. Fac. of Science, Univ.of Malta; 116pp.

CORMACI M. & FURNARI G. (1991). Phytobenthic communities as monitor of the environmental conditions of the Brindisi coastline. Oebalia 17 suppl. 1: 177-198.

CORMACI, M., FURNARI, G., GIACCONE, G., COLONNA, P. & MANNINO, A.M., 1985. Metodo sinecologico per la valutazione degli apporti inquinanti nella rada di Augusta (Siracusa). *Boll. Acc. Gioenia Sci. Nat.*, 18 (326) : 829-850.

D'ANNA, G., GIACCONE, G. & RIGGIO, S., 1985. Lineamenti bionomici dei banchi di mitili di Balestrate (Sicilia occidentale). *Oebalia* 11 : 389-399.

DIXON, W. J., 1988. (ed.). BMDP Statistical Software Manual. Vol I & II. University of California Press, Berkeley.

ISMAIL, N.S. & AWAD, J., 1987. Effects of sewage dumping on macrobenthic invertebrates in the Jordan Gulf of Aqaba, Red Sea. *Int. Revue ges. Hydrobiol.* 72 (2) : 225-234.

PÉRÈS, J.M. & PICARD, J., 1964. Nouveau manuel de bionomie benthique de la mer Méditerranée. *Rec. Trav. Sta. mar. Endoume*, 18 : 15-30.

		XGHAJRA	CONTROL SITES (GENERALIZED)
TERRESTRIAL ZONE		Inula crithmoides	I. crithmoides
SUPRALITTORAL ZONE		Littorina neritoides: Lagio italica Chthamalus depressus	L. neritoides: L. italica C. depressus
MEDIOLITTORAL ZONE:	UPPER	Chthamalus stellatus Patella rustica: Lichens Seasonal algal belt (e.g. Enteromorpha spp.) *	C. stellatus: P. rustica Encrusting coralline algae Lichens
	LOWER	Monodonta turbinata: Patella spp. Cladophora spp.: Mytilaster minimus* Lepidochitona corrugata: Ulva rigida *	Cyanophyceae M. turbinata
		Fissurella nubecula: Enteromorpha spp. * Cardita calyculata: Corallina elongata * Cyanophyceae: Bypnea musciformis * Polycheates: Gigartina acicularis * Dendropoma petraeum	Encrusting coralline L. corrugata: Patella spp. Laurencia spp. Dendropoma petraeum
INFRALITTORAL ZONE:	(UPPER)	C. elongata *: Pterocladia capillacea * Vermetus triquetes: D. petraeum C. calyculata, Ostrea edulis: M. minimus * Sponges: Bryozoa	Cystoseira spp.: V. triquetes Padina pavonica: Halimeda tuna Psenia stricta M. minimus

Fig.2. Comparison of zonation paterns at Xghajra and a generalized zonation pattern for the 4 control sites (* denotes nitrophilous species or species commonly found in degraded or polluted situations

HEAVY METAL CONCENTRATIONS IN THE DEEP-WATER SHRIMP *ARISTEUS ANTENNATUS* (RISSO, 1816) FROM WEST MEDITERRANEAN (SE SPAIN)

P. MARTINEZ-BAÑOS[1], C. RODRIGUEZ[2] and J. GUERRERO[2]

[1] Servicio de Pesca y Acuicultura - Región de Murcia. 30201 Cartagena, España

[2] Instituto Español de Oceanografía. 30740 San Pedro del Pinatar (Murcia), España

Mercury, Cadmium, Lead, Copper and Zinc concentrations have been determined in the deep-water shrimp *A. antennatus* (Risso, 1816). Males and females of different size classes were analyzed separately and were sampled from Cabo de Palos and Aguilas, two areas of the coast of Murcia (SE Spain). A high correlation has been found between Hg concentrations and length for females. We have tried to relate the results with biological factors of the species. Specimens were collected in 1991 by commercial bottom-trawl gear seasonallly from April to November from the two sites. Individual shrimps were measured (cefalotorax length), weigthed and dissected. Sex of the specimens was also recorded in the basis of external morphological characteristics. The total number of samples analyzed was 26 corresponding to 193 individuals : 79 males and 114 females. Analyses were performed separately for males and females. All procedures employed in sample preparation and chemical analyses were the usual at the laboratory and have been described before by GUERRERO *et al.* (1988). The concentrations of heavy metal determined for the different areas, year, sex and length of the shrimps are summarized in table I. No significant differences for all metals were found between sites for a given sex and length. Significant differences ($p < 0.05$) in the concentration of mercury between one year old females (Lc = 25 mm) and four year old (Lc > 54mm) were found. The linear correlation coefficient between Hg concentration in muscle of the shrimps and their length was 0.88 and the determination coefficient shows that the model explains the 78% of the variation found. This pattern of correlation in the case of mercury has been observed in many fish species, mollusca, crustaceans and marine mammals.

It is well known that a number of biotic and abiotic factors can influence the accumulation of trace metals in marine organisms. It is considered unlikely that in this case the levels are affected by environmental factors as discharges from coast, or salinity and temperature of the surrounding waters as they can be considered constant at the depth were the samples were taken. The highest concentrations for cadmium, copper, zinc and mercury were found in November, immediately after spawing when the lipidic and proteic body burden and gonadal composition are lowest (MARTÍNEZ-BAÑOS and ROSIQUE, 1994). This is in accordance also to MANCE (1987), who have reported the occurrence of highest heavy metal concentrations in tissue immediately after spawing. In males the seasonal variations follows the same pattern than in females but no correlation can be established as there is no seasonality in the spawing, and adult males can be found during the whole year (MARTÍNEZ-BAÑOS *et al.* 1992). The high concentrations found in females can be due to their longer life cycle and bioaccummulation period. Generally females can live one year more than males (DEMESTRE, 1990). There are no previous studies taking sex and size of the animal and season of the year into account in relation to metal accummulation for *A. antennatus*. The average values (arithmetic mean for both males and females in each region) lie within the range reported by other authors (HERNÁNDEZ *et al.*, 1986 and GUERRERO *et al.*, 1988) for the Spanish mediterranean area. According to these authors no seasonal variations were found, but in our study high correlation was found between concentration and size.

Table I: Heavy metal concentrations in *Aristeus antennatus*.

Date	Area	Sex	N° indiv	Lc (mm)	Weight (g)	µg/g fresh weight				
						Hg	Cd	Pb	Cu	Zn
April	Aguilas	M	6	20±0	3.9±0.3	0.36	0.013	0.079	3.55	9.70
		M	7	25±0	7.1±0.3	0.25	0.009	0.070	4.34	10.53
		F	10	25±0	6.8±0.4	0.35	0.015	0.088	4.63	11.49
		F	11	35±0.5	19±1.2	0.53	0.010	0.079	3.21	10.75
		F	4	54±4.1	54±6.2	0.51	0.010	0.056	3.69	12.72
	C.Palos	M	13	19±0.5	3.8±0.4	0.31	0.008	0,093	3.50	9.91
		M	4	25±0.8	7.0±0.7	0.29	0.012	-	-	-
		F	10	25±0.4	7.7±0.6	0.21	0.010	0.085	2.90	10.16
		F	9	35±0.5	18±0.9	0.47	0.012	0.086	3.16	11.07
July	Aguilas	M	8	22±1.6	5.6±1.1	0.30	0.011	0.058	2.51	10.61
		F	8	25±0.3	7.4±0.5	0.25	0.011	0.054	2.65	12.72
		F	8	35±0.8	17.6±1.6	0.35	0.011	0.052	2.56	13.52
		F	3	59±4.9	61.6±9.2	0.81	0.013	0.045	2.80	11.40
	C.Palos	M	7	19±1.0	3.8±0.5	0.16	0.011	0.092	4.18	10.77
		M	2	28±2.0	9±2.5	0.41	0.020	0.090	2.74	10.29
		F	10	24±0.4	6.7±0.4	0.22	0.010	0.070	2.93	10.83
		F	8	35±0.4	18.2±1.4	0.34	0.007	0.055	2.35	11.71
Nov.	Aguilas	M	8	21±1.2	4.8±0.8	0.23	0.011	0.062	3.20	10.05
		M	6	32±1.1	12.2±1.2	0.53	0.014	0.104	3,21	9.90
		F	6	26±1.1	7.1±1.4	0.27	0.012	0.078	2.18	11.20
		F	10	36±0.4	17.9±0.9	0.38	0.016	0.088	4.21	13.23
		F	3	56±1.6	50.1±3.2	0.87	0.019	0.082	3.45	13.17
	C.Palos	M	8	20±0.4	3.5±0.3	0.59	0.015	0.047	3.08	10.38
		M	10	27±2.3	7.2±1.8	0.70	0.016	0.050	3.12	14.99
		F	10	25±0.7	6.7±0.5	0.38	0.012	0.047	3.98	11.64
		F	4	36±0.8	16.7±0.5	0.55	0.016	0.090	4.94	12.13

REFERENCES

DEMESTRE M, 1990. Biologia presquera de la gamba *Aristeus antennatus* en el mar catalán, Tesis doctoral.

GUERRERO J., M.M. DEYA, C. RODRIGUEZ, A. JORNET, D. CORTES., 1988. IXe Journées Etude Pollutions, Athens, CIESM

HERNANDEZ F., A. PASTOR, J. MEDINA, M. CONESA, R. MELERO and F.J. LOPEZ., 1986. VIIIe Journées Etude Pollutions, Palma de Mallorca. CIESM.

MANCE G., 1987. Pollution Threat of Heavy Metals in Aquatic Environments. Pollution Monitoring Series, Elsevier, London.

MARTINEZ-BAÑOS P. and M.J. ROSIQUE., 1994. Actas VIII° Simp. Ibér. Est. Bentos Marino. 290-291.

MARTINEZ-BAÑOS P. F. VIZUETE, J. MAS., 1992. 1ere Conf. Eur. sur les crustacés. Paris, 31/8-5/9.

IMPACT D'UNE POLLUTION DE TYPE PORTUAIRE SUR LA MACROFAUNE BENTHIQUE DANS UN PORT MÉDITERRANÉEN DU MAROC (PORT DE M'DIQ)

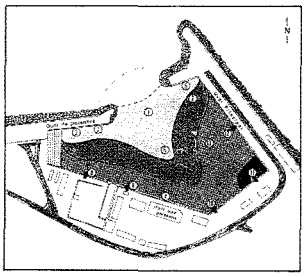
Mohamed MENIOUI[1] et Mohammed Zaher BENABDALLAH[2]

[1] I.S., B.P. 703, Rabat-Agdal et CNR B.P. 8027, Rabat, Maroc.
[2] Faculté des Sciences, B.P. 4010, Beni M'hamed, Meknès, Maroc

L'objectif de cette étude est de donner un premier aperçu sur la macrofaune benthique d'un port marocain (M'diq: 35°40'N, 5°19'W), sa distribution et sa zonation en fonction du degré de pollution, estimé par des bio-indicateurs. Seize stations y ont été échantillonnées et la surface unitaire prélevée, de 900 cm^2, correspond à l'aire minimale (PERES et PICARD, 1964). Dans ce port, 88 espèces et 9 groupes systématiques ont été identifiés : mollusques (44 espèces, 50%), crustacés (21 esp., 47,7%), polychètes (15 esp., 34%), cnidaires et ascidies (2 esp. chacun, 2,27%), des spongiaires, des halacariens, des pycnogonides et des échinodermes qui comptent une seule espèce chacun (1,13%). La connaissance des espèces, de leurs significations écologiques, une analyse factorielle (AFC) adéquate, le calcul des corrélations entre les stations ainsi que l'observation *in situ* des fonds, nous ont permis de délimiter 5 zones. Ainsi, dans le plan factoriel F1*F2 (Fig. 2), l'axe principal F1 exprime la nature du substrat et sépare les 16 stations en deux groupements : celui des substrats meubles (marquées par *), situé du côté positif et celui des substrats durs (marquées par un point), situé du côté négatif. Le second axe F2 exprime surtout le facteur pollution.

La station 11, soumise en permanence à l'effet de rejets domestiques, est la plus éloignée de la passe et la plus confinée. La pollution s'y traduit par une très faible diversité (5 esp., 5% de la faune totale) dominée à 68% par l'ascidie *Styella plicata* indicatrice de pollution (LEUNG TACK, 1971) et à 18% par la polychète des salissures *Hydroides norvegica* (ZIBROWIUS, 1971). Deux autres espèces *(Sycon ciliatum* et *Ciona* sp.) reflètent la richesse du milieu en matière organique, bien qu'elles n'y excèdent pas 5,75% et 2,87% du peuplement. Les corrélations avec d'autres stations sont négatives ou inférieures à 50%. Nous l'avons appelée "Zone à pollution maximale" (PM). Le deuxième groupement est constitué par les stations 8, 10, 9, 12 et 4, situées toutes à proximité d'une source de pollution : égouts (St. 8 et 10), réservoirs de carburant (St. 9 et 12), halle aux poissons (St.4). Les corrélations y sont d'environ 80% et les richesses spécifiques comprises entre 12 espèces (St. 12) et 18 espèces (St.8) ainsi que par la dominance de *H. norvegica* et *Nereis caudata* (85% et 100% de la faune totale). La station 12 comporte une station meuble (*12) et une station dure baignées dans les mêmes conditions. Elles appartiennent donc à la même zone biotypologique que les stations *10 et *13, situées du côté positif de l'axe F1, qui comptent parmi les moins riches (11, 18 et 10 esp.) et les plus affectées. Elles encadrent la zone "PM" et comportent des formes indicatrices des milieux pollués : *Nebalia bipes, Amycla corniculum, Haminaea hydatis, Cerastoderma edule, Scolelepis fuliginosa et Capitelle capitata* qui forment entre 86% et 100% de la faune totale. *Nebalia bipes*, seul crustacé pouvant survivre dans une vase trop polluée, a été identifié dans ces seules stations, rassemblées avec le groupe précédent dans une "Zone polluée"(PO), appelée "zone polluée perurbée" par GRIMES et BAKALEM (1993).

A la station 2 qui graphiquement fait également partie du groupe "PO", les effectifs de *S. fuliginosa* et *C. capitata* chutent alors qu'apparaissent *Polydora antennata* et *Cirriformia tentaculata*. Cette dernière atteint là sa plus forte abondance (92% du total des polychètes) ce qui caractérise la "zone de transition II" de REBZANI (1993) alors que l'abondance de *Parvicardium exiguum* (40% du total des mollusques) y caractériserait la "zone polluée" de GRIMES et BAKALEM (1993). Nous l'appellerons "Zone dégradée"(D). Un autre groupement fourni par cette analyse est celui des trois stations 3, 7 et 5, les plus diversifiées (33, 23 et 21 esp.), situées de part et d'autre de la passe. Les corrélations entre ces 3 stations peuvent dépasser 60% et sont dominées par des espèces qui reflètent la richesse du milieu en matière organique *(C. acherusicum, S. ciliatum, H. hydatis, Jujubinus exasperatus* ou *N. caudata*). Ces stations sont baignées par la même eau que la station 1 située près de la passe, qui constitue avec la station 6 (15 esp.), un autre groupement. La station 1 est relativement plus riche (21 esp.) que la station 6, située un peu plus vers l'intérieur de l'enceinte portuaire. Elles sont essentiellement dominées par l'espèce *Bittium reticulatum* (63% des mollusques). Ceci nous conduit à regrouper ces 2 stations (avec les stations 3, 7 et 5) dans une zone appelée "Zone perturbée" (PE) correspondant à la "zone subnormale" de GRIMES et BAKALEM (1993) ou encore la "zone de déséquilibre" de REBZANI (1993). A la sortie de l'enceinte portuaire, les peuplements sont encore différents de ceux des conditions normales. La pollution portuaire a donc des répercussions sur l'environnement à l'extérieur de l'enceinte portuaire; mais jusqu'à quelle limite ? Nous avons appelé la zone externe "Zone subnormale" (S) et nous avons projeté d'élargir l'étude à l'extérieur de cette enceinte portuaire.



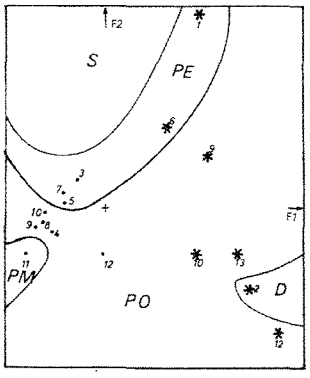


Figure 1 (Gauche): Localisation des stations et zonation du port de M'diq.
Figure 3 (Droite): Distribution des stations-zonation dans le plan factoriel F1*F2

RÉFÉRENCES

BAKALEM A., REBZANI Z. C., ROMANO J.C. et TAHAR M., 1986. Cartographie des peuplements benthiques du Port d'Alger. Rapp. CIESM. 30(2) : 125.

GRIMES S. et BAKALEM A., 1993. Les peuplements benthiques du port de Skikda. *In* "Circulation et pollution des côtes méditerranéennes du Maghreb". Chouikhi *et al.* (Eds), Izmir 307 p.

LEUNG TACK K. 1971, 1972. Etude d'un milieu pollué : le vieux port de Marseille. Influence des conditions physico-chimiques sur la physionomie des peuplements des quais. *Tethys* 3(4) : 767-826.

REBZANI-ZAHAF C., 199. Le peuplement macrobenthique du port d'Alger. Impact de la pollution. Rapp. Symp. Int. Poll. Mer, Casablanca, 11 p.

ÉVALUATION DE QUELQUES MÉTAUX LOURDS DANS DES SÉDIMENTS ESTUARIENS RÉCENTS DES CÔTES SYRIENNES (MÉDITERRANÉE ORIENTALE)

S. NOUREDDIN, S. MAGHAMES & B. NEIMEH
Institut de Recherches Marines, B.P. 2242, Université de Tichrine, Lattaquié, Syrie

Les travaux relatifs à l'accumulation des métaux lourds à l'état de traces dans les sédiments estuariens récents en Syrie sont très peu nombreux et réalisés généralement de manière occasionnelle. Dans le cadre d'une étude géochimique de quelques estuaires des côtes syriennes, débouchant dans la Méditerranée orientale, nous avons recherché les concentrations de quelques métaux lourds à l'état de traces dans les sédiments estuariens récents.

Les principaux résultats présentés ont été acquis au cours d'un programme de prélèvements effectués entre août 1991 et juillet 1992. Deux estuaires ont été retenus pour effectuer cette étude : celui de la rivière Al-Kabir Al-Chimali (ERKC) et celui de la rivière Al-Sin (ERS). Les prélèvements ont été réalisés manuellement en plongée autonome, à l'aide d'un tube en PVC de 4.5 cm de diamètre; ils se sont limités aux douze premiers centimètres de la colonne sédimentaire. Les carottes ont été découpées en tranche de 2 cm d'épaisseur. Quatre métaux ont été recherchés : le cadmium, le cuivre, le plomb et le zinc. Les échantillons ont subi un traitement à l'acide nitrique (AMINOT & CHAUSSEPIED, 1983), et l'analyse a été réalisée à l'aide d'un spectrophotomètre d'absorption atomique (Perkin-Elmer 2380) avec flamme.

Les concentrations obtenues pour l'ensemble des métaux recherchés ne présentent pas, en général, de valeurs très élevées. Leur ordre d'importance dans les sédiments est en bon accord avec la littérature internationale concernant d'autres sites marins côtiers, et également avec leur présence dans la colonne d'eau; en effet, leurs concentrations dans les sédiments deviennent de plus en plus importante selon l'ordre : Cd, Cu, Pb et Zn.

La distribution verticale du cadmium, du cuivre et du plomb dans la colonne sédimentaire de l'ERKC se montre plutôt homogène. Celle concernant le zinc varie suivant la période de carottage, elle présente parfois des concentrations relativement plus importantes dans la couche supérieure de la colonne sédimentaire étudiée; une distribution quasi-homogène est tout de même mise en évidence en sub-surface de cette colonne sédimentaire.

Les variations saisonnières de ces éléments métalliques diffèrent d'un élément à l'autre et d'un estuaire à l'autre. Le cadmium ne présente pas, en général, de variations importantes (pour l'ERKC: concentration moyenne = 1.81 ug/gpoids sec, n = 25 mesures, $\sigma n = 0.17$). Le zinc présente, par contre, les variations les plus importantes dans les deux estuaires.

Par comparaison avec d'autres sites méditerranéens côtiers, les sédiments estuariens étudiés ne semblent pas présenter une pollution métallique alarmante. Il convient, tout de même, d'approfondir cette étude en recherchant la spéciation de ces métaux, en identifiant et surveillant les sources de pollution voisines.

	Cd	Cu	Pb	Zn
Sédiments (ug/gpoids sec)				
ERKC	1.3-2.2	7.9-25.3	11.4-21.2	81.3-222.4
ERS	2.5-3.8	7.1-33.9	23.0-44.3	46.1-242.9
Eaux estuariennes (ug/l)				
ERKC	0.2-3.5	1.2-9.7	1.0-34.7	5.2-377.7
ERS	0.1-3.7	0.7-6.9	ND -44.3	1.4-315.5

Tableau 1 : Concentrations maximales et minimales des métaux analysés dans les sédiments étudiés et dans les eaux estuariennes.

REFERENCES

AMINOT A. & CHAUSSEPIED M., 1983. Manuel des analyses chimiques en milieu marin.. Brest, BNDO/Document., 393 p.

L

LEVELS OF SEVEN PCB CONGENERS IN THE GULF OF ELEFSIS

V - Y. PANAGIOTOPOULOU[1], D. TSIPI[1], A. HISKIA[1], M. SCOULLOS[2]

[1] General Chemical State Laboratory of Greece, 115 21 Athens, Greece
[2] Depart. of Chemistry, Division III, Athens University, 105 71 Athens, Greece

Despite the fact that PCB's have been identified since the sixties as some of the most acute pollutants of the Mediterrean Environment, it is surprising how little concrete information is available, even today, about their actual levels in some parts of the Mediterranean Sea. Information about their speciation between dissolved and particulate phases and at various depths of the water column, as well as between the water and sediments of the site, are also rare. In the present work we present the results of a survey carried out in the Gulf of Elefsis, a semi-enclosed embayment near Athens which receives the effluents of a number of industries and is affected also by the Athens sewage outfalls which are located near its eastern entrance (Fig. 1.) The substances studied were the following PCB congeners : PCB-18, -28, -52, -101, -153, -138, and -180. The focus of the present paper is the discussion of the levels of their concentrations in water, suspended solids and sediments taken from five sites shown in the map. Solid-phase extraction (C_{18}) procedure applied prior to the separation. Single PCBs were determined by HRGC-ECD on two capillary columns of different polarity, with internal standard. In the Tables 1 and 2, the mean - minimum - maximum concentrations of the PCB congeners are given from the water samples (suspended solids and dissolved water phase) during the winter and summer of 1992. The mean concentrations of the PCB congeners in sediments and their minimum - maximum values are presented in Table 3. The sediment samples have a total organic carbon content from 4.65 to 1.36 % (dry weight). The concentrations show the real tendency of the PCBs and to a lesser extent of other organochlorine compounds to accumulate more in suspended solids and sediments than in the dissolved water phase following their hydrophobic nature. Some discrepancies from the general rule could account on the existance of colloidal determined with the dissolved phase of the water samples (BAKER *et al.*, 1986; ALBAIGES *et al.*, 1991; KAMLET *et al.*, 1998).

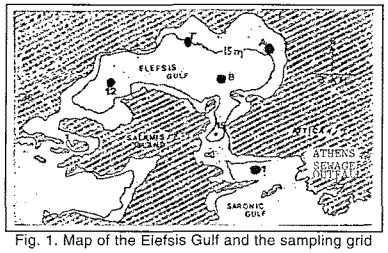


Fig. 1. Map of the Elefsis Gulf and the sampling grid

	Concentrations - Winter			Concentrations - Summer		
	Mean	Mini.	Maximum	Mean	Mini.	Maximum
1. PCB-18	0.644	M.A	0.92	0.546	0.28	0.86
2. PCB-28	1.394	0.93	2.56	2.016	0.92	2.8
3. PCB-52	M.A			M.A		
4. PCB-101	1.372	0.95	2.91	1.68	0.96	2.65
5. PCB-153	0.518	0.211	1.00	0.582	0.23	1.26
6. PCB-138	0.155	M.A	0.39	0.045	M.A	0.15
7. PCB-180	M.A			0.035	M.A	0.12
SUM PCBs	4.083			4.904		

Table 1. Mean - Minimum - Maximum Concentrations (ng/lit) of the PCBs congeners in Suspended Solids during the winter and summer of 1992 in the Gulf of Elefsis

	Concentrations - Winter			Concentrations - Summer		
	Mean	Mini.	Maximum	Mean	Mini.	Maximum
1. PCB-18	0.052	0.02	0.1	0.030	M.A	0.08
2. PCB-28	0.57	0.1	0.88	0.263	0.11	0.43
3. PCB-52	M.A			M.A		
4. PCB-101	0.173	0.06	0.5	0.166	0.05	0.5
5. PCB-153	0.687	0.078	1.23	0.585	0.053	1.65
6. PCB-138	0.031	M.A	0.115	0.02	M.A	0.028
7. PCB-180	M.A			M.A		
SUM PCBs	1.513			1.064		

Table 2. Mean - Minimum - Maximum Concentrations (ng/lit) of the PCBs congeners in the Dissolved Water phase during the winter and summer of 1992 in the Gulf of Elefsis

In a attempt to assess the total concentrations of PCBs from Table 3, we have include in Table 4 mean concentrations of PCBs in sediments, with their minimum - maximum values, from different regions of the Mediterranean Sea, quoted directly from UNEP's MAP Technical Reports Series n°39 (1990) keeping in mind the different methodologies used.

	Concentrations - Sediments		
	Mean	Mini.	Maximum
1. PCB-18*			
2. PCB-28*			
3. PCB-52*			
4. PCB-101	7.59	0.53	17.00
5. PCB-153	16.5	3.1	34.5
6. PCB-138	17.7	2.4	13.1
7. PCB-180	13.35	1.65	30.4
SUM PCBs	55.14	7.68	119.5

Table 3. Mean - Minimum - Maximum Concentrations (µg/Kg, dry weight) of PCBs congeners in sediments. * *Not identified due to the matrix interferences of the sample's background*

Area	Concentrations - sediments		
	Average	Minimum	Maximum
Aegean Sea *	155	0.6	775
Coastal France & Spain*	85.5	0.2	15850
Northern Adriatic Sea*	24.1	N.D	332
Southeastern Med. Sea*	2.2	0.6	51.1
Gulf of Elefsis ** (present work)	48.05	7.68	119.5

** In most cases the concentrations have been expressed in comparison to Aroclor reference standards or as a concentration of decachlorobiphenyl (product of the perchlorination method)*
*** The total of PCBs has been expressed as a summation of all PCB congeners*

Table 4. Average - Minimum - Maximum Concentrations of PCBs in sediments from different regions of the Mediterranean Sea (µg/Kg, dry weight)

Despite the fact that the maximum values determined in the Gulf of Elefsis are among the lowest included in the Table, the mean and especially the minimum values are particularly high. This reflects a generalised pollution due to the fact that the Gulf plays effectively the role of a trap of the pollution generated by the neighbouring industries and the sewage outfalls as a result of the geomorphology of the area.

REFERENCES

BAKER J.E., CAPEL P.D. & EISENREICH S.J., 1986, *Environ. Sci. Technol.*, 20, 11: 1136-1143

ALBAIGES, J., BAYONA, J.M., VALLS, M., FERNANDEZ, P., PORTE, C., TOLOSA, I., 1991, *In* MAP Technical Report Series n° 59

KAMLET M.J., DOHERT, R.M., CARR P.W., MACKAY D., ABRAHAM M.H. & TAFT, R.W., 1988. *Environ. Sci. Technol.*, 22 : 5

TRACE METALS DISTRIBUTION IN A DREDGE MATERIAL DISPOSAL SITE OF THE NORTHERN TYRRHENIAN SEA

David PELLEGRINI[1], Michele GIANI[2], Francesco MELLARA[3] and Massimo GABELLINI[1]

[1] Istituto Centrale per la Ricerca Applicata al Mare (ICRAM), Roma, Italia
[2] Istituto Centrale per la Ricerca Applicata al Mare (ICRAM), Chioggia, Italia
[3] Centro Interuniversitario di Biologia Marina, Livorno, Italia

About 100.000 m^3 of sediments dredged in the harbour of Livorno (of the 507.000 m^3 authorized) had been dumped in a circular area of about 0.2 km^2 at a depth of 40 m, when the present study was carried out. Sediments were collected by a gravity core or by box corer in 19 stations (fig. 1) during March 1992. Subsamples for chemical and grain size analysis were obtained from 3 cm sections of the cores. Harbour dredged sediments were characterized by elevated sand content whereas the natural sediment texture in the disposal area is silty clay (IMMORDINO *et al.*, 1993). Surficial grain size composition shows an increase of the sand percentage in the dumping site and westwards (Fig. 2); a sand increase was also evident in the deeper sections of O5 core (8-11 cm: 33.1%; 16-19 cm: 32.0 %), inside the disposal site. The more elevated sand content in the south-east stations may be due to a northwest transport of biodetrital sediments from Meloria Shoals (GABELLINI *et al.*, 1994). Lead, cadmium and chromium concentrations were determined by GFAAS and mercury by CVAAS, after total digestion with HF/$HClO_4$/HNO_3/HCl mixture in a microwave system under pressure (GIANI *et al.*, 1994). On the basis of previous studies (ENEA, 1992) lead and cadmium concentrations resulted more elevated in harbour sediments (Pb : 26 - 213 mg/kg d.wt., Cd : < 5.3 mg/kg d.wt.) than in the disposal site before dumping (Pb : 29 mg/kg d.wt., Cd : 0.11 mg/kg d.wt.). Mercury concentration in harbour sediments were highly variable, chromium on the contrary was less concentrated in harbour sediments. Comparisons with our data are complicated by the use of different acid digestion (hot HNO_3/HCl mixture) which not always allow the total dissolution of the matrix. The Cd and Pb surficial distributions show similar patterns (fig. 2). Lead and cadmium, as well sand, seem to be useful tracers of the bulk of the dredge material. Lead concentrations found in surficial sediments range from 27 to 54 mg/kg with an average content similar to that found by LEONI *et al.* (1991) in silty clay and clayey silt of the Northern Tyrrhenian Sea, considered polluted by a diffuse anthropogenic input. Pb concentrations decrease from the top downwards in the cores, reaching 16-29 mg/kg in the 16-19 cm sections. The profiles are similar to the ones found in other short cores of the Northern Tyrrhenian Sea (LEONI *et al.*, 1991). Cadmium reaches the maximum concentrations in the O5 and P5 (up to 1.13 mg/kg) stations, these values are up to 10 times more elevated than in stations less influenced by the dumping. Cadmium distribution along the cores shows an increase at the top layer at the disposal site and in the stations S5 and R2, probably due to the Arno river sedimentation. The more elevated mercury concentrations correspond to the core collected inside the disposal site and are about three times more elevated than the average surficial concentration of all the other stations (0.11±0.02 mg/kg d.wt.). Average chromium concentration in the stations less influenced by the dumping is 265+98 mg/kg d.wt. with a decrease in the stations inside and around the dumping site (176+59 mg/kg d.wt.), probably due to a lower chromium content in the dumped harbour sediments. Other elevated concentrations have been reported by LEONI *et al.* (1991) south of the study area (127-176 mg/kg d.wt.), and by COSMA *et al.* (1980) in the zone just north of the study area (300 mg/kg as average value). Further determinations on the samples collected over a wider area in a survey carried out in 1994, will allow a better evaluation of the Arno river influence in the study area.

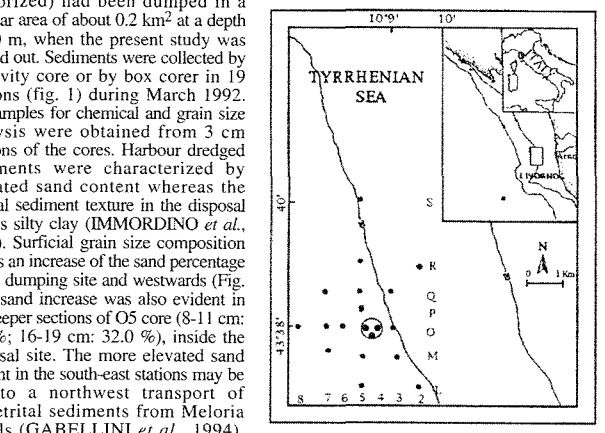


Fig.1. Sampling stations (•) in the dumping site (○) and in the surrounding area.

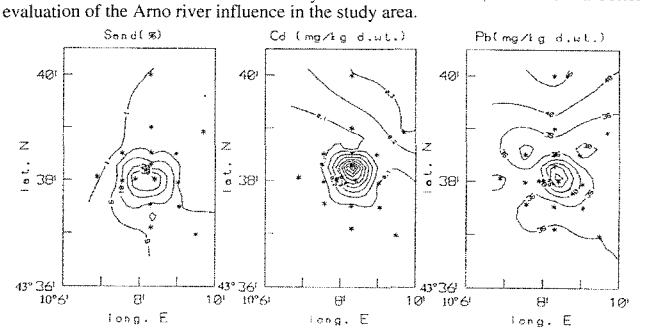


Fig. 2. Surficial distribution of sand, cadmium and lead.

REFERENCES

COSMA B., DRAGO M., PICCAZZO M. and TUCCI S., 1980. Heavy metals in high Tyrrhenian sea sediments (...) Atti Soc. Tosc. Sci. Nat., Memorie, Serie A, 87 : 145-161.

ENEA, 1992. Rapporto finale per la caratterizzazione del sito di discarica dei fanghi di escavo del porto di Livorno in relazione allo sversamento dei primi 100.000 mc di materiale. ENEA, vol. 1-3.

GABELLINI M., PELLEGRINI D., GIANI M., SPAGNOLI F. and ZANOLI S., 1994. Dati preliminari sulle variazioni dei caratteri granulometrici dell'area di scarico dei materiali dragati dal porto di Livorno. *In* Atti del X congresso A.I.O.L., 367-374.

GIANI M., GABELLINI M., PELLEGRINI D., COSTANTINI S., BECCALONI E. and GIORDANO R., 1994. Concentration and partitioning of Hg, Cr and Pb in sediments of dredge and Disposal Sites of the Northern Adriatic Sea, Sci. Total. Environ., in press.

IMMORDINO F. and SETTI M., 1993. Caratterizzazione granulometrica e mineralogica dei sedimenti superficiali dell'alto Tirreno tra La Spezia e Livorno. Serie Studi Ambientali "Arcipelago Toscano", ENEA, 51-64.

LEONI L., SARTORI F., DAMIANI V., FERRETTI O. and VIEL M., 1991. Trace element distributions in surficial sediments of the Northern Tyrrhenian Sea: contribution to heavy metal pollution assessment. *Environ. Geol. Water Sci.*, 17 : 103-116.

CONCENTRATION OF MERCURY IN MARINE PHANEROGAM *POSIDONIA OCEANICA*. PRELIMINARY RESULTS

Christine PERGENT-MARTINI, Patricia GUERRINI

EP CNRS 0075, Ecosystèmes Littoraux, Université de Corse, BP 52, 20250 Corte, France

The accumulation of trace metal in the tissues of marine phanerogams has been the object of numerous studies. It seems that mercury concentration measured in the leaves of *Posidonia oceanica* is representative of levels present in sea water (AUGIER *et al.*, 1978). The base of the leaves of *Posidonia oceanica* (sheath) presents the particularity of remaining attached along the rhizome, after the fall of the limb, and of remaining within the matte for several decades. Furthermore, thanks to the variations in thickness of the sheath (a cycle limited by two minima of thickness corresponds to one year), it is possible to date their period of formation very precisely with a technique which can be assimilated to dendrochronology : lepidochronology (PERGENT, 1990). These remains of sheath, which can inform us on the conditions prevailing at the time of their formation (temperature, turbidity, sedimentation rate,..) can also memorize levels of radioelements present in the environment (e.g. Caesium 137 in CALMET *et al.*, 1991).

For the purpose of the present study, 48 orthotropous rhizomes were collected in January 1993 from one site of the bay of Calvi (Corsica) by scuba-diving at -10 m depth. They were separated into three equal parts dissected according to the lepidochronological method. *Posidonia oceanica* leaves were separated according to their type (adult or intermediate). The old sheaths, present on each rhizome were very carefully detached, respecting the distichous insertion order (rank), and numbered from the more recent (near the living leaves) to the older (near the base). Sections of rhizomes, delimited by two minima thickness (corresponding to one annual cycle), were equally selected. Mineralization of the samples was realised with a mixture of acids (sulfonitric) and oxygenated water, in Nalgene FEP Teflon bottles put in the microwave. Dosage of mercury was performed with the help of a flameless atomic absorption spectro-meter (MAS 50B, Perkin Elmer). If, for a given structure (blades, old sheaths or rhizomes), mean mercury concentration levels vary according to its age, one notes that registered levels in the rhizomes are higher than those registered in other structures (Figure 1). This preferential accumulation of mercury in the rhizomes is already mentioned in the literature on sites of weak environmental contamination (MASERTI *et al.*, 1988). The date of sampling (season) could however also play an essential role in the accumulation of mercury in the leaf tissues of *P. oceanica*, as this has already been observed with other phanerogams (WARD, 1987). Our results show that mercury concentrations do not occur at random in the sheaths of *P. oceanica*. Concentrations are strongly correlated to the weight of sheaths (y = 0.29 - 0.55 x, r = 0.74). By erasing this correlation it is possible to assess the difference between theoretical concentration (only due to the weight) and observed concentration (Figure 2). It then appears that this difference reflects seasonal patterns of accumulation. They provide evidence of the occurrence of cycles of mercury concentration, according to sheath insertion rank. These cycles are synchronized with the sheath thickness variation cycles.

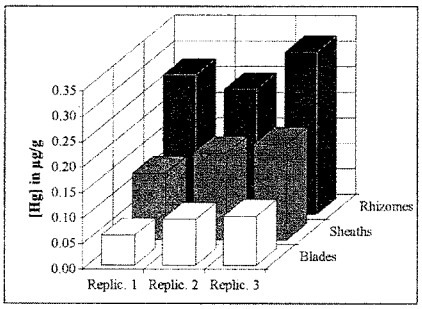


Figure 1 : Mercury levels in the different tissues of *Posidonia oceanica* collected in January 1993.

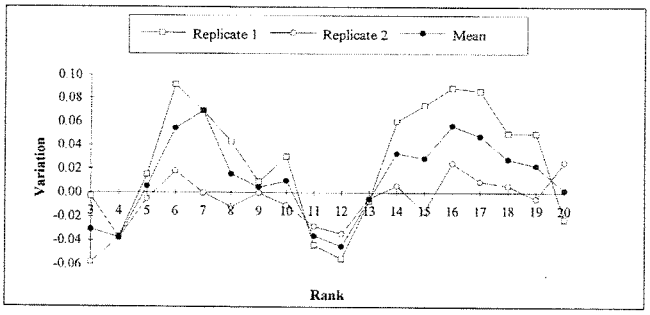


Figure 2 : Variation (in µg/g) between theoretical and observed mercury concentration, in *Posidonia oceanica* sheaths, on the basis of the insertion rank.

In the future, we plan to investigate whether the accumulation of trace metal by *Posidonia oceanica* shows significant variations according to the season. We shall therefore analyse trace metal concentrations in the various leaf tissues of *Posidonia oceanica* over an annual cycle.

ACKNOWLEDGEMENTS. This study constituted part of the European Communities Commission programme : STEP C0063.

REFERENCES

AUGIER H., GILLES G., RAMONDA G., 1978. Recherche sur la pollution mercurielle dans le golfe de Fos (Méditerranée, France) : degré de contamination par le mercure des Phanérogames marines *Posidonia oceanica* Delile, *Zostera noltii* Horneman et *Zostera marina* (L.). *Rev. internation. Océanogr. méd.*, 51-52 : 55-69.

MASERTI B.E., FERRARA R., PATERNO P., 1988. *Posidonia* as an indicator of mercury contamination. *Mar. Pollut. Bull.*, 19(8) : 381-382

CALMET D., CHARMASSON S., GONTIER G., MEINESZ A., BOUDOURESQUE C.F., 1991. Chernobyl Radionuclides in the Mediterranean Seagrass *Posidonia oceanica*, 1986-1987. *J. Environ. Radioactivity*, 13 : 157-173.

PERGENT G., 1990. Lepidochronological analysis in the seagrass *Posidonia oceanica* : a standardized approach. *Aquat. bot.*, 37 : 39-54.

WARD T.J., 1987. Temporal variation of metals in the seagrass *Posidonia australis* and its potential as a sentinel accumulator near a lead smelter. *Marine Biology*, 95 : 315-321.

THE SEA OF MARMARA AS A POLLUTING ROUTE

Colpan POLAT, Suleyman TUGRUL

Institute of Marine Sciences, Middle East Technical University, P.O.Box 28, 33731, Erdemli, Icel, Turkey

The Sea of Marmara, an enclosed basin which permits exchanges of distinct different waters from the Black and Aegean seas through the two narrow and shallow straits of Bosphorus and Dardanelles, acts as a receiving water environment not only for industrial and domestic waste discharges but also for chemical pollutants from the adjacent seas. Accordingly, excess amount of organic matter and nutrients entering the Marmara surface waters both from the Black Sea through Bosphorus surface flow and from land-based sources, which have drastically modified the marine ecosystem, reach as far as the Mediterranean Sea through the Dardanelles Strait.

The annual rates of chemical exchanges between the Marmara Sea and the two adjacent seas including the entrainment fluxes are illustrated in Fig. 1, together with recent estimates of water fluxes and annual means of chemical properties of the exchanging waters. Systematic data of inorganic and particulate nutrients and organic carbon were obtained during the national oceanographic studies in the Marmara Sea whereas the dissolved organic nitrogen and dissolved ammonia data were derived from the literature as discussed recently in POLAT and TUGRUL (1994). It appears that the entrainment free loads of total phosphorus (TP), total nitrogen (TN) and total organic carbon (TOC) entering the Aegean Sea from the Marmara Sea through the Dardanelles are about 1.0×10^4, 1.3×10^5 and 1.8×10^6 tonnes per year respectively. Such loads are very similar to the inputs from the Black Sea into the Marmara surface layer, but at least 3-4 times larger than the exports from the Aegean Sea through the Dardanelles. As also clearly seen from the mean concentration data displayed in the figure, the saline waters of Mediterranean origin in the lower layer of the Marmara basin, which are poor in nutrients before entering the basin, are enriched with such chemicals by nearly ten-fold relative to its initial value at the Dardanelles Strait due to the input from the productive surface layer of the Marmara Sea. The decay of organic matter sinking from the surface waters have resulted in an oxygen deficiency in the lower layer of the Marmara Sea though the Aegean inflow into the basin is saturated with dissolved oxygen.

When the Marmara inputs to the Aegean Sea through the Dardanelles (see Fig.1) are compared with the riverine, atmospheric and Atlantic loads (COSTE *et al.*, 1988, BETHOUX *et al.*, 1992, MONTÉGUT, 1993), it can be suggested that they contribute to the nutrient pools of the Mediterranean Sea at the comparative levels with the anthropogenic inputs, but being about an order of magnitude less than the Atlantic input as expected.

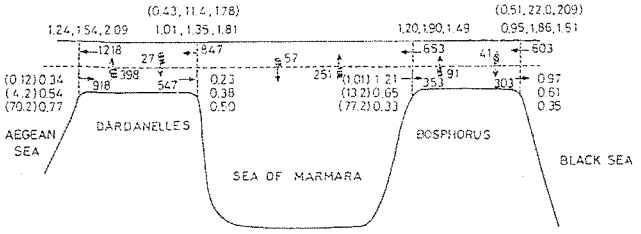


Fig. 1. The annual fluxes of water (values given with the arrows, km^3y^{-1}, BESIKTEPE, 1991), TP, TN and TOC through the Marmara Sea and the straits. The numbers are in the order of phosphorus ($x10^4$ tons P), nitrogen ($x10^5$ tons N) and organic carbon ($x10^6$ tons C). The values in parantheses are the annual average concentrations (µM) of TP, TN and TOC.

REFERENCES

BESIKTEPE S., 1991. Some aspects of the circulation and dynamics of the Sea of Marmara. Ph. D. Thesis, METU- Institute of Marine Sciences, Erdemli-Icel, Turkey, 226 pp.

BETHOUX J.P., MORIN P., MADEC C. and GENTILI B., 1992. Phosphorus and nitrogen behaviour in the Mediterranean Sea. *Deep-Sea Research*, 39(9) : 1641-1654.

COSTE B., LE CORRE P. and MINAS H.J., 1988. Re-evaluation of the nutrient exchanges in the Strait of Gibraltar. *Deep-Sea Research*, 35(5) : 767-775.

MONTÉGUT G.C., 1993. Cycle biogéochimique du carbone dans le bassin méditerranéen. International Advanced Study Course, Nice, August 30-September 17, 1993.

POLAT C. and TUGRUL S., 1994. Nutrient and organic carbon exchanges between the Black and Marmara seas through the Bosphorus Strait Continental Shelf Research (in press).

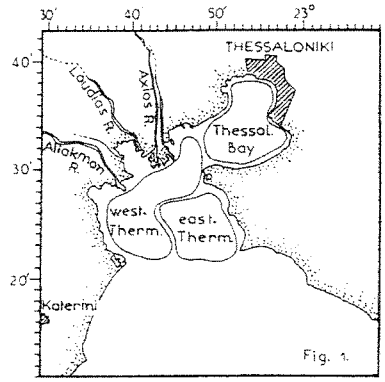
L

ASSESSMENT OF THE NUTRIENT LOADS RECEIVED BY THERMAIKOS GULF, N.W. AEGEAN SEA

R. PSYLLIDOU-GIOURANOVITS, F. VOUTSINOU-TALIADOURI and E. GEORGAKOPOULOU-GREGORIADOU

National Centre for Marine Research, 16604 Hellinikon, Greece

Thermaikos Gulf, a shallow (max depth 40 m) semi-enclosed water embayment in the Northwestern Aegean Sea, is of particular environmental interest for both scientists and authorities. It is exposed to the domestic wastes of the city of Thessaloniki (approx. 1,200,000 inhab.) as well as the industrial effluents of the nearby industrial zone. Moreover the estuaries of three rivers Axios, Loudias and Aliakmon are influencing the hydrological regime of the area. Previous oceanographic studies concerning eutrophication conditions of the Gulf were carried out during the years 1975-76 and 1985-86. The aim of this study is to investigate the present eutrophication conditions and to compare them with those of the previous studies. Water samples were collected during four cruises from September 1992 to August 1993 at standard depths in 19 stations. The methodology used was the same as in the 1975-1976 study. The Gulf was divided into three water masses (subareas) : the Thessaloniki bay (A), the Western (B) and the Eastern (C) gulf (BALOPOULOS, 1985). The sampling stations as well as the above mentioned subareas are shown in Figure 1. Table 1 shows the integrated mean values of nutrients and the ΣN/P ratio at the four cruises. It also gives the mean value of every constituent in each subarea. The relatively higher concentrations especially of PO_4 but also of NH_4 and NO_3 are measured in Thessaloniki bay, while NO_2 and SiO_4 values are relatively low.



Area	Sampling	PO_4-P	SiO_4-Si	NH_4-N	NO_2-N	NO_3-N	ΣN/P
	9/1992	0.10	0.92	0.16	0.05	0.06	3.66
Thessaloniki	1/1993	0.54	1.02	0.93	0.32	1.22	3.95
Bay	4/1993	0.63	0.99	0.51	0.09	0.50	1.85
	8/1993	0.34	0.67	0.69	0.09	0.43	6.10
	Mean	0.40	0.90	0.57	0.14	0.55	3.89
	9/1992	0.06	1.11	0.16	0.04	0.12	5.89
Western	1/1993	0.24	0.64	0.41	0.25	0.75	5.92
Thermaikos	4/1993	0.18	1.03	0.22	0.04	0.34	3.13
	8/1993	0.09	0.76	0.14	0.06	0.18	6.01
	Mean	0.14	0.89	0.23	0.10	0.35	5.24
	9/1992	0.07	1.42	0.20	0.10	0.20	5.87
Eastern	1/1993	0.18	0.59	0.36	0.26	0.55	6.37
Thermaikos	4/1993	0.11	0.76	0.18	0.03	0.19	3.58
	8/1993	0.06	0.56	0.18	0.07	0.32	9.52
	Mean	0.11	0.83	0.23	0.12	0.32	6.34

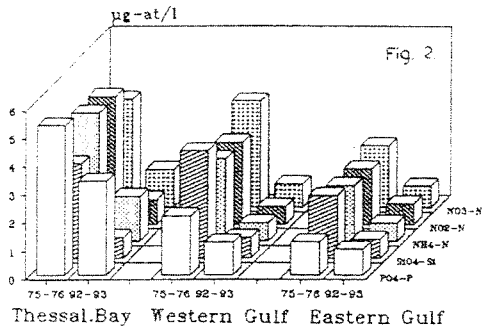
Table 1. Integrated mean values of nutrients (µg-at/l) of the three subareas.

These high concentrations are due to the untreated wastes that are discharged into the bay near the city of Thessaloniki through the central sewage outfall. Moreover the mean values of the three subareas are multiplied with the volume of the water masses to calculate the total amount of nutrient loads in g-at.10^6. These amounts are divided by the reference amounts for the same volume of the water masses (concentrations characterizing the oligotrophic Aegean waters (FRILIGOS, 1981) multiplied with the volume of the three water masses) to give the degree of eutrophication of each subarea (Table 2).

Table 2. Eutrophication degree of the three subareas.

Area	PO4-P	SiO4-Si	NH4-N	NO2-N	NO3-N
Thessaloniki bay	3.33	0.74	1.59	0.88	1.31
Western Thermaikos	1.17	0.73	0.64	0.63	0.83
Eastern Thermaikos	0.93	0.68	0.64	0.74	0.76

The present eutrophication conditions are compared with those of the 1975-76 study (FRILIGOS, 1990) in Figure 2. It is obvious, from Figure 2, that the present conditions are better than those which existed about twenty years ago. This must be due to the reduction of the load of the wastes after the operation of the Sewage Treatment Plant. Also the diminution of the rainfalls has as a consequence the decrease of the nutrients originating from the fertilizers used for agricultural purposes at the surrounding areas. The results reported in this study can be used as reference values in the future when the Treatment Plant will be in full operation.



REFERENCES

BALOPOULOS E. Th., 1985. An analysis of the coastal water masses in the northwestern Aegean Sea. Thalassographica, vol 8, pp. 7-17.

FRILIGOS N., 1981. Enrichment by inorganic nutrients and oxygen utilization rates in Elefsis Bay. *Mar. Pollut. Bull.* 12 (12) : 431-436.

FRILIGOS N., 1990. Eutrophication conditions in the Thermaikos Gulf. 2nd Chemistry Symposium of Cyprus and Greece on "Chemistry and Environment", Athens, Greece. Tome 2, pp. 316-323 (in Greek).

TRACE METALS IN THE SHELL OF THE MEDITERRANEAN MUSSEL *MYTILUS GALLOPROVINCIALIS*

F. REGOLI[1], M. MAURI[2] and E. ORLANDO[1]

[1] Dipart. di Biomedicina Sperimentale, Univ. di Pisa, Via Volta 4, 56100 Pisa, Italy
[2] Dipart. di Biologia Animale, Univ. di Modena, Via Università 4, 41100 Modena, Italy

Marine bivalves are known to accumulate high levels of metals in their tissues and are commonly used in biomonitoring studies. An alternative approach to the analysis of metals in soft tissues may be the use of shell which would allow also the comparison with fossil samples. However, since the processes regulating metal accumulation in the shell remain still unclear, further research is needed to validate the use of this structure in monitoring programs.

The aim of this work was a preliminary characterization of trace metal levels in the shell of the Mediterranean mussel *Mytilus galloprovincialis*, the distribution of these elements among the various mineralogical components and the influence of organism size on metal levels in the shell.

Mussels were collected respectively from a clean and a trace metal polluted area of North Tyrrhenian Sea; after removing soft tissues, the shells were cleaned with a nylon brush and dried at 45°C until constant weight. Metals were determined in whole shells, in shells without the periostracum and in the calcite and aragonite phases. Periostracum was removed by solubilization in 20% Tetramethylammonium hydroxide (TMAH) at 60°C for 3 h; calcite and aragonite components were separated (after a preliminary treatment with TMAH) at 400°C for 1 h. Samples were digested with concentrated nitric acid and metals determined by atomic absorption spectrophotometry. The standard addition method was used to eliminate matrix effects. The influence of organism size on trace metal concentrations was assessed in mussels from both the populations by analysing whole shells of different size classes.

Metal concentrations in the shell of mussels from Scarlino (polluted site) and La Spezia (clean site) are reported in Table 1. Previous studies on trace metal concentrations in soft tissues of mussels from both the populations indicated, for Scarlino, high environmental levels especially of Mn, Pb and Fe (REGOLI, 1992; REGOLi and ORLANDO, 1993, 1994a,b).

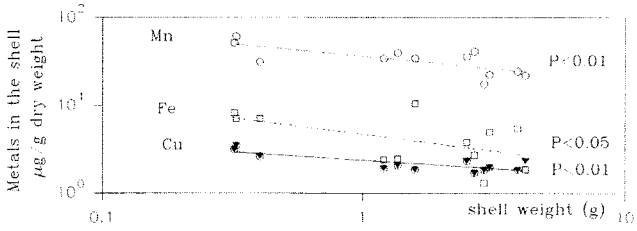
These findings were partially confirmed by data on shell analysis which showed higher concentrations of Mn and especially of Pb in mussels from Scarlino. On the other hand, no statistical difference was observed for Fe in whole shells of mussels from the two populations. This fact could be explained hypothesizing that iron, mainly present in seawater as oxide-hydroxide compounds, cannot be secreted, in this chemical form, into the extrapalleal fluid. Similar values of Cu and Zn in whole shells of mussels from both the populations agree with data previously reported for soft tissues.

The removal of periostracum generally reduced the concentrations of metals (with some exceptions) indicating an important contribution of this component to the total metal burden in the shell. The distribution of metals in calcite and aragonite differed according to the element, but was rather similar in mussels from the two populations.

Table 1. Trace metal concentrations (g/g dry weight)) in different mineralogical components of shell in *Mytilus galloprovincialis* from a polluted (Scarlino) and a clean (La Spezia) site. (Mean values standard deviations, n=5)

Metal	Site	Whole shells	Shells without periostracum	Calcite	Aragonite
Mn	Scarlino	27.0±8.66	15.1±2.92	11.4±5.72	1.84±0.97
	La Spezia	6.08±2.25	5.58±2.22	7.66±1.99	1.13±0.53
Fe	Scarlino	3.58±1.65	0.78±0.45	1.19±0.99	2.39±1.47
	La Spezia	2.30±1.35	0.24±0.39	1.01±0.67	4.89±4.55
Pb	Scarlino	16.6±4.04	16.4±3.80	15.5±2.74	9.77±2.26
	La Spezia	< 0.5	< 0.5	< 0.5	< 0.5
Cu	Scarlino	1.44±0.39	0.40±0.05	0.79±0.16	0.63±0.26
	La Spezia	1.50±0.17	0.38±0.09	0.61±0.21	0.85±0.57
Zn	Scarlino	0.94±0.63	0.58±0.12	0.60±0.19	0.74±0.20
	La Spezia	0.55±0.08	0.19±0.12	0.43±0.14	0.62±0.36

The influence of size on metal concentrations in whole shell resulted significant only for Mn, Fe, Cu and Zn in mussels from the polluted site (Figure 1).



From data reported in the present study, trace metal concentrations in shells seem to reflect the bioavailability of these elements in the environment, even though the variability of the results is generally higher than with the analysis of soft tissues. Shell could represent an useful tool in biomonitoring studies especially when soft tissues are not available.

REFERENCES

REGOLI F. (1992). Lysosomal responses as a sensitive stress index in biomonitoring heavy metal pollution. *Mar. Ecol. Prog. Ser.* 84 : 63-69

REGOLI F., ORLANDO E. (1993). *Mytilus galloprovincialis* as bioindicator of lead pollution : biological variables and cellular responses. *Sci. Total Envir.* Supplement, Vol. 2 : 1283-1292

REGOLI F., ORLANDO E. (1994a). Accumulation and subcellular distribution of metals (Cu, Fe, Mn, Pb and Zn) in the mediterranean mussel *Mytilus galloprovincialis* during a field transplant experiment. *Mar. Pollut. Bull.* in press

REGOLI F., ORLANDO E. (1994b). Seasonal variation of trace metal concentrations (Cu, Fe, Mn, Pb, Zn) in the digestive gland of the Mediterranean mussel *Mytilus galloprovincialis*: comparison between a polluted and a non polluted site. *Arch. Environ. Contam. Toxicol.* 27(1) : 36-43

SPATIAL DISTRIBUTION OF HEAVY METALS IN MEDITERRANEAN MUSSEL *MYTILUS GALLOPROVINCIALIS* FROM SPANISH MEDITERRANEAN COAST

C. RODRIGUEZ, J. GUERRERO, J.M. BENEDICTO and A. JORNET

Centro Oceanográfico de Murcia, Box 22. 30740 San Pedro del Pinatar (Murcia). España

In 1991 the Spanish Mediterrenanean Mussel Watch Project by the Spanish Institute of Oceanography was formed to monitor spatial distributions and temporal trends of persistent toxic substances in marine waters. 20 different stations along the spanish mediterranean coast were chosen. As suggested by some authors (GOLDBERG *et al.*, 1978; PHILLIPS, 1980) mussel was chosen as sentinel organism for indicating the levels of pollutants because this species offers most of the requisite features of a biological indicator, is a permanent resident of geographically fixed sites, common and abundant for ease of collection.

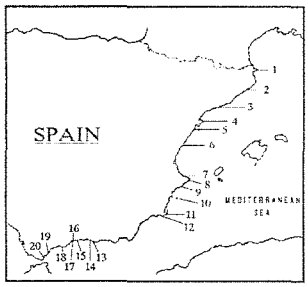
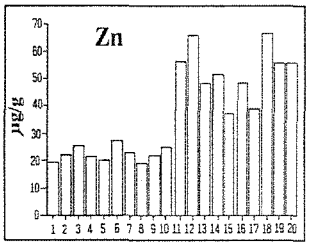
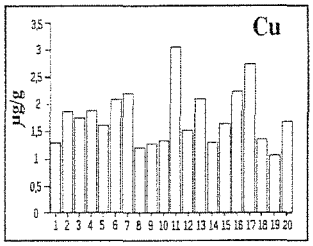


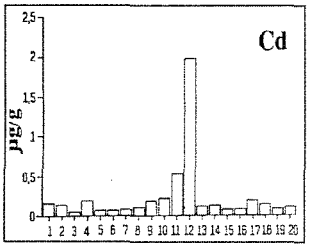
Fig. 1. Sampling locations

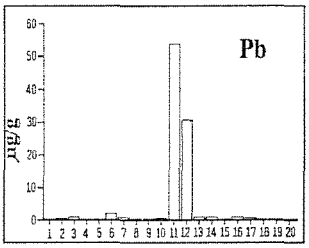
1. Cadaqués	2. Blanes
3. Cabo Salou	4. Cabo Tortosa
5. Peñíscola	6. Burriana
7. Cabo Cullera	8. Cabo La Nao
9. Isla de Benidorm	10. Isla de Tabarca
11. Portman	12. Cartagena
13. Motril	14. Almuñécar
15. Lagos	16. Málaga–Boya
17. Málaga	18. Rocas de Mar
9. Punta Chullera	20. Punta Carnero

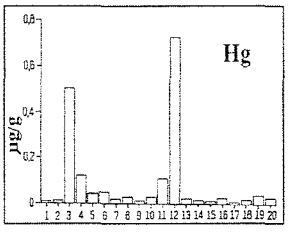
It is well known that different factors affect the heavy metal content in shellfish. In order to avoid part of the variability, sampling was made under standardized conditions. Whenever it was possible, mussels were collected from natural populations, at the same time of the year (May 1991), at the same depth, from the same substrata and of the size 3–4 cm (shell length). In the areas of Tortosa, Algameca, Tabarca and Málaga where no natural mussel beds in the coast were found, the molluscs were taken from buoys in order to cover the whole spanish mediterranean coast. The specimens were collected by divers and taken to the laboratory for measuring and preparation. They were dissected in a laminar–flow clean bench. Soft parts were used for analysis. Approximately 1gr. of lyophilized, homogenized tissue was digested with 3 ml. of nitric acid in closed teflon digestion vessels. The digested samples were cooled and transferred to 25 ml volumetric flask for dilution. Reagents blanks and the certified reference material MA–M–2/TM from the International Atomic Energy Agency were runned with each batch. Concentrations of metals were measured with an Atomic Absortion Spectrometer (Perkin Elmer 605 compiled to a HGA 76B programmer). Mercury was determined by the cold vapour method (Perkin Elmer 2380, MHS 20). In the following figures the distributions for copper, zinc, cadmium, lead and mercury in the different populations along the Spanish mediterranean coast from North to South are presented. All results are expressed in mg kg^{-1} fresh weight. A significant increase of zinc concentrations in mussels from south of the area of Portman–Algameca (32.8–75.8) than northern (17.7–30.7) was found. This should be considered due to the natural conditions and characteristics of the populations. The high levels of zinc and the extremely high peaks of Cd and Pb found in Portman and Cartagena are influenced by effluents from the industrial town of Cartagena and from the exploitation of a lead–zinc mine (RODRÍGUEZ DE LEÓN *et al.*, 1984). Mercury occurred in high concentrations in C. Salou and Algameca near the industrialized towns of Tarragona and Cartagena respectively. The elevated levels in C. Tortosa migth be due to the discharges of the Ebro river. The distribution of Cu shows a rather uniform pattern. As suggested by PHILLIPS (1976) mussels should not be relied upon as accurate indicators of copper in the marine environment. The results show that high heavy metal concentrations are found in stations located near areas receiving discharges from urban or industrial effluents or rivers. From this first study it seems that the mediterranean mussel is a good indicator of the spatial heavy metal distributions along the Spanish mediterranean coast. Results from following years would show temporal trends in the concentrations.











REFERENCES

BAYNE, B.L., K.R. CLARKE and M.N. MOORE. 1981. *Aquatic. Toxicol.*, 1 (3,4) : 159–174

GOLDBER, E.D., V.T. BOWEN, J.W. FARRINGTON, G. HARVEY, J.H. PARKER, R.W. RISEBROUGH, W.ROBERTSON, E.SCHNEIDER and E. GAMBLE. 1978. *Environ. Conserv.* 5 : 101–125.

GUERRERO, J., M.M. DEYA, C. RODRIGUEZ, A. JORNET and D. CORTÉS. 1988. IXe Journées Étud. Pollutions, Athens. CIESM.

PHILLIPS, D.J.H. 1976. *Mar. Biol.* 38 : 59–69

RODRIGUEZ DE LEON, A., J. MAS, J. GUERRERO and A. JORNET. 1984. VIIe Journées Étud. Pollutions, Lucerne. CIESM.

POTENTIAL ENVIRONMENTAL HAZARDS FROM THE VOLATILE ORGANIC EMISSIONS OF THE GREEN ALGAE *ULVA RIGIDA* AND *ENTEROMORPHA INTESTINALIS*

Vassilios ROUSSIS[1], Heleni CABERI[2], Michael SCOULLOS[2]

[1] NCSR "Demokritos", Institute of Biology, Agh. Paraskevi, 153 10, Greece

[2] University of Athens, Department of Chemistry, Environmental Chemistry and Chemical Oceanography, Panepistimiopolis Athens, 157 01, Greece

The oceans, besides their most important function which is the regulation of the global climate through both physicochemical and biological processes, produce a third to half of the global oxygen supply and help in the regulation of the primary greenhouse gas, carbon dioxide, by the mechanism known as the biological pump (WEBER, 1994). Scientific interest has increasingly been turning to the sea in search for medical cures and unique compounds. Marine life, a relatively unstudied frontier, has produced antileukemia drugs from sea sponges, bone graft material from corals, diagnostic chemicals from red algae and many other useful agents (KHOL, 1993; HODGSON, 1991). But the treasury of the oceans might never been fully exploited since the flow of nutrients into oceans has at least doubled since prehistoric times and sediments have nearly tripled as a result of human activity (UNEP, 1992). The recently introduced pollutants degrade estuaries and coastal waters by blocking sunlight, suffocating fish and coastal habitats and importing pathogens and toxins. They have also contributed to the increased incidence of algal blooms that release deadly toxicants into the surrounding waters (YASUMOTO & MURATA, 1993).

The cosmopolitan green algae *Ulva rigida* and *Enteromorpha intestinalis* are among the most commonly found marine organisms in polluted and eutrophicated ecosystems. The population density of these aggressive macroalgae can reach excessive levels especially during the summer months (HO, 1981). All around the Mediterranean basin the wave-protected coastal areas are facing seasonal blooms of these intertidal species. In continuation of our program aiming at the evaluation of the impact these algal blooms might have at their immediate habitat, we focused our recent efforts on the identification of the volatile secondary metabolites produced by *U. rigida* and *E. intestinalis*. In the past we studied the composition of the non-volatile metabolites of *U. rigida*, as well as the variation of the chemical profile when the organism is stressed, exposed to increased concentrations of heavy metals (SCOULLOS *et al.*, 1992).

The intense odour of *U. rigida* and *E. intestinalis* and the precedence of harmful volatile emissions from other marine organisms (MANLEY *et al.*, 1992; GSCHWEND *et al.*,1985) were the main reasons that intrigued us to analyze the composition of the volatile chemicals of these macroalgae. Both species were collected from the gulf of Elefsis and the experiments were performed in the laboratory under simulated natural conditions (temperature, photoperiod, medium). The algae were placed in air-tight fiberglass containers and the air of the system was recycled for 24 hrs via a membrane pump. The volatile organic metabolites were trapped in glass traps loaded with surface active polymers. The experiment was repeated with sea water from the same area in the absence of algae, to determine whether the detected chemicals were true volatile metabolites of the algae or contaminants of the water. The quantification and identification of the volatile constituents were performed by Gas Chromatography and Gas Chromatography-Mass Spectrometry analyses. The results of the experiments revealed that significant amounts of low molecular weight halogenated and non halogenated hydrocarbons are produced and liberated, by the algae, at the atmosphere during their life cycle. Besides the head-space analyses, quantities of the algae were subjected to steam distillation-extraction (Likens Nickerson method) (GODEFROOT *et al.*, 1981) for the quantitative determination of the total volatile chemical content of the organisms. Many of these chemicals were found to be oxygenated water-soluble hydrocarbons, that most probably are liberated from the algae in the water. Eventhough the percentages of the most harmful secondary metabolites within the total emitted chemicals have been determined, precise calculation of the actual amounts of these metabolites per Kg of biomass need to be performed so that it would be possible to assess if these notorious to the stratospheric ozone layer chemicals constitute an alarming factor.

Some Volatile Metabolites of *U. rigida* and *E. intestinalis*.

Hydrocarbons :
Pentane, Octane, 1,2 Dimethyl cyclopentane, Decane

Oxygenated Hydrocarbons :
Hexanal, Heptanol, 2-Ethyl hexanol, Nonanal

Aromatic Hydrocarbons :
Toluene, Benzaldehyde

Halogenated Hydrocarbons :
Dichloromethane, Tribromomethane

Sulfur containing Metabolites :
Dimethyl sulfide

ACKNOWLEDGMENTS

The financial support of the project was provided from the Ministry of Research and Technology under the form of a PENED programme

REFERENCES

WEBER P., State of the World 1994 (Safequarding Oceans) 1994, p. 41, Earthscan Publications Ltd, London.

KOHL J. The Ocean's Bounty : Untapped Pharmacy, Currents (Woods Hole Oceanographic Institution, Woods Hole Mass.) Spring 1993.

HODGSON G., Drugs from the Sea, 1991, *Far Eastern Economic Review*, 11.

Marine Pollution from Land-based Sources : Facts and Figures (January/June 1992), UNEP Industry and Environment.

YASUMOTO T., MURATA M., 1993, Marine toxins. *Chem. Rev.*, 93 :1897.

HO Y.B., 1981, Mineral element content in *Ulva lactuca* with reference to eutrophication in the Hong Kong coastal waters, *Hydrobiologia*, 77 : 43.

SCOULLOS M.J., CABERI H., ROUSSIS V., 1992, Effects of cadmium on the physiology and chemical composition of the green algae *Ulva rigida* (C. Ag.), *Rapp. Comm. Int. Me Medit.*, 33 : 183.

MANLEY S.L., GOODWIN K., NORTH W.J., 1992, Laboratory production of bromoform, methylene bromide and methyl iodide by macroalgc and distribution in nearshore southern California waters. *Limnol. Oceanog.*, 37 : 1652.

GSCHWEND P.M., MACFARLANE J.K., NEWMAN K.A., 1985, Volatile halogenated organic compounds released to seawater from temperate marine macroalgae, *Science*, 227 : 1033.

GODEFROOT M., SANDRA P., VERZELE., 1981, New method for quantitative essential oil.

L

LABORATORY AND FIELD INVESTIGATIONS ON THE EFFECTS OF TRIBUTYLTIN ON THE OYSTER, *OSTREA EDULIS*

M. SAMMUT[1], V. AXIAK[1], A. VELLA[2], D. AGIUS[1], R. CASSONE[1], P. CHIRCOP[1], and B. MINTOFF[2]

[1]Marine Ecotoxicology Laboratory, Depart.of Biology, [2] Department of Chemistry University of Malta. Msida, Malta

Tributyltin (TBT) is the main active ingredient in organotin-based antifouling paints. It is possibly the most toxic substance that is intentionally introduced into the marine environment and its ecological impact at extremely low levels, particularly on molluscs, has been confirmed through a number of laboratory and field investigations (AXIAK *et al.*, in press). The present work reports on cytopathological effects in the adult oysters *Ostrea edulis* on laboratory exposure to environmentally realistic levels of TBT, with special reference to digestive cell atrophy. Moreover, the likely ecological significance of this effect is discussed and evaluated through field studies. These investigations form part of a programme of evaluation of biological impact of TBT in the Mediterranean.

Adult specimens of *Ostrea edulis* were exposed to nominal concentrations of TBT chloride (dissolved in ethanol) of 100 and 10 ng l^{-1} in unfiltered sea water. Exposure was conducted for 96 hours with test mixtures being kept aerated throughout the whole period and renewed every 24 hours. Oysters were left unfed during the experiment, which was conducted at 17°C with a photoperiod of 12:12 dark to light hours. After exposure, surviving animals were fixed in Bouin's reagent, dehydrated in ethanol, cleared in xylene and embedded in paraffin wax. 7um thick sections were then stained with Erlich Haematoxylin and Eosin. The effect of TBT on the digestive cells (Type I) of the diverticula of the digestive gland was assessed by measuring the heights of such cells under a magnification of X 1000.

The mean height of digestive cells decreased from 13.44 um (sd: 2.25) in controls to 11.43 um (sd: 2.41) in animals exposed to 10 ng l^{-1} of TBT, with effects being found to be statistically significant at $P < 0.001$ with Tukey's multiple comparison tests at this and all other levels of exposure.

In another experiment, shell thickening was evaluated using a shell thickness index (STI) in *Ostrea* collected from five coastal sites around the major harbour area (Grand Harbour and Marsamxett) in Malta (Central Mediterranean). Malta's major yacht marinas and ship-repairing yards are located there. Oysters were also collected from a clean reference site which is only exposed to limited boating activities. These sites differed markedly in the levels of organotins in sediments as well as in the water column as measured by GC-FPD (AXIAK *et al.*, in press). Mean seasonal levels of TBT in superficial sediments at the different sites, expressed as ng Sn per g dry weight ranged from 18 to 210 for Grand Harbour; from 18 to 410 for Marsamxett; and below detection limit at a reference site outside the harbours. Levels of TBT at 1m depth in the water column ranged from 8 to 120 for Grand Harbour; and from 8 to 40 ng Sn /g DW for Marsamxett.

STI which is the ratio between valve length to valve thickness, has been used as an index of abnormal shell growth in bivalves. Low STI values are indicative of shell abnormalities which are usually due to the formation of various types of minute chambers within the shell matrix (BRYAN and GIBBS, 1991). The mean STI value for the lower valve of animals collected from the reference site was found to be 21.65, while mean STI values (for the lower valve) for animals collected from Grand Harbour and Marsamxett ranged from 9.9 to 10.5 and from 8.5 to 11.8, respectively. STI for both upper and lower valves indicated that shell abnormalities were significantly higher in areas within the Grand Harbour and Marsamxett Harbour than in the reference site.

Digestive cells of bivalves are known to undergo atrophy on exposure to a wide range of contaminants. This cell atrophy is normally correlated with catabolic metabolism and reduced bioenergetic balances of bivalves. However such cytological stress in *Ostrea* as reported here, has never been recorded for any contaminant at such low environmental concentrations. It is here proposed that reduced bioenergetic balance and the consequent reduction in body weight may lead to a shell chambering effect in this test species as shown in the field experiment. Shell abnormalities in *Ostrea*, as indicated by STI were partly due to the formation of minute water-filled chambers within the shell. New shell deposition by an animal with reduced somatic growth may lead to the formation of such chambers. Such shell abnormalities may be part of a general stress syndrome which may be elicited by a range of contaminants and not just TBT. Nonetheless, the laboratory experiments reported here, provide evidence that this species is particularly sensitive to low levels of TBT (10 ng/l) in sea water, exhibiting significant atrophy in digestive cells.

L

REFERENCES

AXIAK, V., VELLA, A.J., MICALLEF, D., CHIRCOP, P., and MINTOFF, B. Imposex in Hexaplex trunculus: First results on biomonitoing of TBT in the Mediterranean. *Marine Biology*. In press.

BRYAN G.W., and GIBBS P., 1991. Impact of low concentrations of tributyltin (TBT) on marine organisms : A Review, *in* M.C Newman and A.W. McIntosh (Eds.). Metal ecotoxicology: Concepts and Applications. Lewis, Ann Arbor, Boca Raton, Boston, 1991, pp. 323-361.

This work was partly funded by the Commission of European Communities through its MedSPA programme under contract number MEDSPA-91-1/UK/002/INT/06.

COASTAL MARINE LITTER IN THE CENTRAL MEDITERRANEAN : BASELINE INFORMATION ON BEACH STRANDING, COASTAL DENSITIES AND RATES OF PHOTODEGRADATION

C. SCIBERRAS and V. AXIAK

Marine Ecotoxicology Laboratory Department of Biology, University of Malta. Msida, Malta

Floating marine debris is considered to be a potential environmental hazard especially in semi-enclosed waters such as the Mediterranean. The Maltese Islands lie at the junction between the two major Mediterranean basins, and therefore are ideally situated to provide data on the background levels of the densities of marine litter of the whole region as well as on exchanges of floating debris between the Western and Eastern Mediterranean.

The present paper reports on a study undertaken in 1991-92. It presents baseline qualitative and quantitative data on marine litter within the Central Mediterranean coastal areas, as found stranded on beaches, or floating at sea. It also reports on the rate of degradation of certain types of plastics. The potential economic impact of litter on sea crafts was also assessed.

Marine litter can originate from two sources : ship traffic or land-based sources. Two beaches located near Fomm ir-Rih (North-East, Malta) were surveyed in August 1991 and April 1992 in order to assess qualitatively and quantitatively the extent of pollution by marine debris originating from sources at sea. These beaches were remote from built-up areas and with very limited accessibility, so that most of the litter found stranded on their shoreline must have originated from the sea. The extent of litter on the beaches was investigated using belt transects. The litter was counted, weighed, and its age, fabrication material and previous contents recorded. Litter densities, percentages by weight and number of the various components were calculated. Frequency distributions showing the geographical origins of containers in the study areas were tabulated and correlated with shore profiles and degree of beach exposure.

The slopes of the beaches under study were generally found to be low and litter tends to be easily trapped on this type of shores. This study revealed a wide range of fabrication materials and contents for beach-stranded marine litter. The mean density of shore-stranded litter ranged from 60 to 650 g/m^2 according to position on the beach away from the waterline. This was in general comparable to that reported in other regions in the Mediterranean. Plastic litter occupied the highest percentage by number of items, with wood being also predominant. Litter was found to be both of local and foreign origin.

Litter density distribution down-shore, generally showed a bimodal distribution. Containers marketed or manufactured locally accounted for the modal classes of both beaches. Twelve different countries of origin were identified in all. Most containers were current production types but one was manufactured in 1986. Litter accumulation was found to be influenced by the extent of exposure of beach localities as well as by local patterns of wind and sea currents.

Sea surveys in inshore waters around Malta were carried out during winter 1991. Floating megalitter was counted and recorded from a boat moving in a straight course or along the shore at distance of up to 3 km offshore. Only litter which was observed within 10 m on either side of the boat was recorded. The area of water observed in a single trip was therefore equal to the distance covered by the boat multiplied by 20 m. The density (frequency) of litter was then expressed as the number of items observed per unit area.

An overall mean density of 41 items per km^2 of floating megalitter was recorded for the coastal areas around Malta. In 55% of the surveys, the highest densities were recorded for plastic debris. The highest mean density for plastics in fact was 158 items per km^2. The next predominant type of litter at sea was found to be wood at 21.6%, with nylon occurring at 5.1%.

A survey amongst boat owners indicated that the negative economic implications of such marine litter may be considerable. A number of cases were reported in which water intakes of yachts were clogged by floating litter, or litter got entangled with craft propellers or drive shaft. Cases of floating debris interfering with radar signals were also reported.

The rates of photodegradation of plastics exposed to different environmental conditions were measured by tensile testing of standard test strips. The rates of photodegradation were assumed to be negatively correlated with the exposure time required by the test strips to reach 5% elongation before they break (ie. time required by plastic to turn brittle). Two types of plastics were utilized: low density polyethylene (LDPE) and enhanced photodegradable ethylene-carbon monoxide co-polymer (E/CO). Test strips were exposed to sunlight either in dry conditions (on a roof top) or while continuously washed by seawater, being attached to floating platforms at sea. Exposure experiments were simultaneously undertaken in Malta and U.K. (Farnborough College of Technology). Data for E/CO test strips is tabulated below :

Mean Exposure days required by test strips to reach 5% elongation

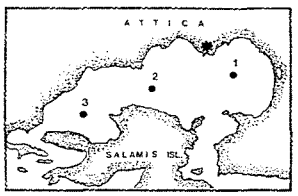
	Jul-Sep.	Oct-Feb.
Wet Exposure in Malta	21	25
Dry Exposure in Malta	13	22
Wet Exposure in U.K.	71	74
Dry Exposure in U.K.	65	60

These data indicate that rates of degradation were substantially lower at sea and under U.K. prevalent climatic conditions. Other data on the tensile properties of the exposed plastics, will be published elsewhere.

EVOLUTION OF TRACE METAL LEVELS AND MAGNETIC PROPERTIES IN SEDIMENTS OF THE ELEFSIS GULF, GREECE

M. SCOULLOS[1], E. FOUFA[2] and M. DASSENAKIS[1]

[1] Chemistry Depart. Athens University, Panepistimioupoli, 105 71 Athens, Greece
[2] General Chemical State Lab. of Greece, An. Tsocha 16, 115 21 Athens, Greece



The small (68 km^2) and shallow (max depth 33 m) Gulf of Elefsis (Fig. 1) located in the northern part of the Saronikos Gulf, close to Athens and Pireaus, has received particular attention due to its scientific and ecological importance and its relation to the economy of the country. It is connected to the rest of the Saronikos Gulf with two natural narrow and shallow channels and receives considerable amounts of industrial effluents from crude oil refineries, shipyards, steel works, cement, food, electroplating and chemical industries, mainly in its eastern part where the town and the port of Elefsis are located. In this study an attempt is made to trace any trend in the pollution of the area which is continously studied from our laboratory since 1974 (SCOULLOS *et al.*, 1979; SCOULLOS *et al.*, 1986; FOUFA, 1993) by using a combination of chemical partitioning of trace metals and measurements of some magnetic parameters in the sediments for two sampling periods (1988 and 1992). Sea bottom sediments were collected from three sampling stations during two oceanographic cruises on May 1988 and May 1992, using a van Veen box corer. Sediment samples were wet sieved through a 61 µm nylon net, dried at 40°C and subjected to sequential extraction. The reagents used for this procedure were (TESSIER *et al.*, 1979) : **1** : $MgCl_2$ 1M, pH7; **2** : CH_3COONa, 1M, pH 5; **3** : $NH_2OH.HCl$ 0.04M, CH_3COOH 25%; **4** : H_2O_2 30%, 0.02M HNO_3, 85%; **5** : HF-HNO_3-$HClO_4$ 120°C. The sediment fractions extracted respectively broadly correspond to A : Easily exchangable, B : Carbonates, C : Fe-Mn oxides, D : Organics, E : Detrital silicates. Metal concentrations were measured with a Perkin Elmer 2380 AAS system. The magnetic parameters measured were the following (SCOULLOS & ZERI, 1993) :

- 1. Magnetic susceptibility x represents the ease with wich a material can be magnetized. It was measured using a Bartington susceptibility meter at 0.1T and 0.47kHz.
- 2. Saturation isothermal remanent magnetization (SIRM), represents the magnetic content and is measured in a fluxgate magnetometer (Minispin, Molspin Ltd) after placing the sample in a strong d.c. magnetic field (1000 mT) at 24°C temperature
- 3. Frequency depended susceptibility xFd%, defined by the ratio $[(x_1-x_h)/x_1]*100$, (x_1:0.1T, 0.47kHz - x_h: 1T, 0.47kHz). It helps in idenifying very fine grains (< 0.03 µm).

Pb-1988			%			total
Station	A	B	C	D	E	µg/g
1	15	10	62	6	7	274
2	12	12	62	6	8	191
3	11	11	62	7	9	169
Pb-1992						
1	19	14	52	10	5	264
2	19	15	50	10	6	230
3	20	15	49	10	6	216

Cu-1988			%			total
Station	A	B	C	D	E	µg/g
1	2	4	52	34	8	188
2	3	5	46	36	10	111
3	2	4	48	34	12	105
Cu-1992						
1	2	3	54	32	9	176
2	3	4	48	33	12	123
3	2	3	51	34	10	121

Zn-1988			%			total
Station	A	B	C	D	E	µg/g
1	4	5	55	27	27	632
2	2	6	46	31	31	332
3	3	6	40	23	23	181
Zn-1992						
1	3	5	57	26	9	606
2	3	3	59	20	15	346
3	3	5	44	23	25	206

Mn-1988			%			total
Station	A	B	C	D	E	µg/g
1	1	21	62	9	7	1223
2	1	22	58	9	10	734
3	1	25	53	0	12	701
Mn-1992						
1	1	19	63	9	8	1100
2	1	20	59	10	10	776
3	0.1	19	59	10	12	655

Fig.2. Fractionation of trace metals in surface sediments

The total metal content of the sediments (Fig. 2) reveals that the sediments of the eastern part of the Gulf (st. 1) are enriched in trace metals. Increased concentrations of magnetic particles of anthropogenic origin were also observed at the same station during the 1988 sampling as it becomes clear from the high SIRM and x and the low xFd% values. The SIRM and x values at station 1 were found reduced at the 1992 sampling to the levels of stations 2 and 3 (Fig. 2). This may indicate a reduction of anthropogenic inputs in the area during the period 1988-92, due to the cease of some industrial activities (such as production of iron and steel). Metal concentration levels were similar in the two sampling periods but a slight decrease of total values was observed at station 1 followed by a clear increase at stations 2 and 3. This is probably caused by remobilization and/or transport of metals from particles and sediments of the eastern part of the gulf to the western part. That means that the eastern part acts now not only as a sink but also as secondary pollution source. The sequential extraction procedure for trace metals revealed that the main fraction of the examined metals was connected with Fe-Mn oxides (Fig. 1). High proportion of Cu and Zn was found in the organic fraction whereas elevated percentage of Mn and Pb was connected with carbonates. The percentage of metals held into the alumino-silicate lattice was rather limited and only for Zn exceeded 20%. Significant differentiations in metal partitioning between the two samplings were not observed. From Fig. 3 becomes clear that the variations of SIRM and x were similar with the corresponding variations of trace metal concentrations.

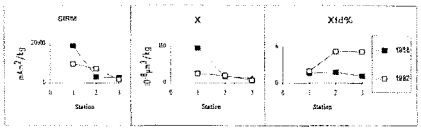


Fig.3. Magnetic measurements in surface sediments

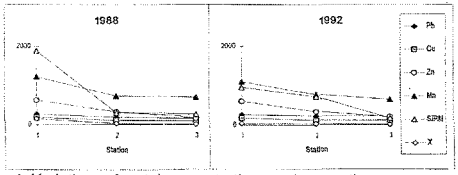


Fig.4. Variations of metal concentrations and magnetic measurements

REFERENCES

M.J. SCOULLOS, F. OLDFIELD &R.THOMPSON, 1979. *Mar. Poll. Bull.* 10 : 287-91
M.J. SCOULLOS & F. OLDFIELD, 1986. *Mar. Chem.* 18 : 249-68
E. FOUFA, 1993. Heavy metals-magnetic measurements of Saronikos Gulf. MSc Thesis
A. TESSIER, P.G. GAMBELL & M. BISSON, 1979. *Anal. Chem.* 51 : 844.
M.I. SCOULLOS & C. ZERI, 1993. *Oceanol. Acta*, 16,1 : 53-61.

POLYCYCLIC AROMATIC HYDROCARBONS (PAHS) IN THE NEARSHORE SUPERFICIAL SEDIMENT OF BOUISMAIL'S BAY (ALGERIA)

B. SELLALI[1], S. HADJ-AMAR[1], B. BOUDJELLAL[1] and A. CHOUIKHI [2]

[1] ISMAL, Marine Pollution Laboratory, POBox 90 Algiers 1st nov. 16003, Algeria
[2] INOC, POBox 49, 35211, Izmir, Turkey

The stability of the sedimentary phase and its important role in the accumulation of chemicals makes it interesting for monitoring purposes of PAHs. In order to check their concentrations, twenty six stations were sampled in the Bouismail's bay (fig. 1) during the summer 1992. This bay is surrounded by small touristic and/or urban settlements where agriculture is the main activity. Four marinas and fishing ports are present in the area and three important rivers discharge their waters in the bay : Mazafran, Nador and Beni-messous.

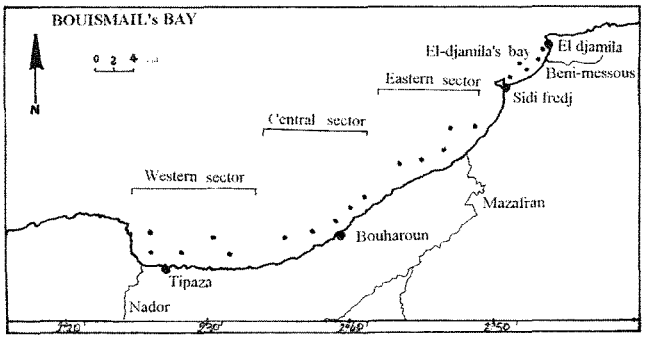


Fig. 1: Bouismail's bay : sampling stations

Sediments were collected with a Van-Veen grab and stored in glass flasks at - 18°C. The analysis was held using UVSF according to the IOC (1982) protocole. Results are expressed in µg/g dry weight (chrysene equivalents). Intercalibration exercises were carried out on a lyophilised material coded SDK 1 (IAEA, Monaco). In order to estimate the percentage of PAHs in accordance with the number of aromatic rings, the synchronous spectra technique, as described by LLYOD (1971), is used. The data in table 1 are given by having divided Bouismail's bay into three major sectors. Following a decreased PAHs concentrations diagram : western, central and eastern sectors; El-djamila's bay can be integrated into what we defined as the eastern sector. Standard deviations are high : this is due to the heterogenous distribution of PAHs in each sector. Petroleum products inputs are important at all stations : 2, 3 and 4 rings PAHs are present in elevated proportions (> 70 %); diagenic and / or pyrolytic compounds are also present in all samples : they range from 12 to 34 %.

SECTOR		PAHs µg/g	2 rings (%)	3-4 rings (%)	5 & + rings (%)
El djamila	range	0.11 - 1.18	23.6 - 33.4	27.5 - 47.8	12.7 - 22
Bay.	mean	0.72	30.7	40.1	18.8
n = 5	S D	0.49	2.9	7.5	3.7
Eastern	range	0.26 - 1.24	21.9 - 38.5	30.4 - 45.2	14.6 -32.1
sector	mean	0.69	33.3	37.8	19.1
n = 5	S D	0.39	6.8	5.3	7.3
Central	range	0.46 - 3.06	17.2 - 30.2	35.4 - 45.2	21.1 - 34.3
sector	mean	1.46	25.5	41.4	26.4
n = 5	S D	0.99	5.4	3.4	4.8
Western	range	0.72 - 4.23	32.1 - 40.2	37.0 - 45.2	11.7 - 21.2
sector	mean	2.22	36.1	40.8	16.3
n = 5	S D	1.37	3.6	3.3	3.6
Sidi fredj	n = 2	8.6	49.2	28.9	14.2
port		13	19.7	51	24.1
Bouharoun	n = 2	3.9	33.1	41.3	21.5
port		8.7	47.9	24.4	12.9
El djamila port	n = 1	3.4	35.8	39.4	16.6
Tipaza port	n = 1	7.8	21.5	40.5	34.1

Table 1 : PAHs concentrations in the superficial sediment of Bouismail's bay.

Harbour levels appear high : these particular sites are influenced by touristic and fishing activities which increase during the summer.

A part from the ports, the arithmetic means indicate that Bouismail's bay is only moderately polluted in comparison with other regions of the Algerian coastline, where PAHs concentrations range from 1.2 to 36 (µg/g) in Algiers' bay, and from 1.9 to 28.8 (µg/g) in Arzew's gulf (SELLALI *et al.*, 1993). Compared with data given for Habibas islands (0.087 µg/g), a site considered as a reference sector (SELLALI *et al.*, 1992), the studied area appears to be contaminated by PAHs.

REFERENCES :

IOC, 1982. The determination of petroleum hydrocarbons in sediments. Manual and guides n°11 intergovernmental oceanographic commission, Paris.

LLOYD J.B.F. , 1971. The nature and evidential value of the luminescence of automobil engins oils and related materials. part I : synchronous excitation of fluorescence emission. *Journal of Forensic Science Society.* 11 : 83 - 94.

SELLALI B., AMAROUCHE N., DEBBICHE S., CHOUIKHI A. et BOUDJELLAL B., 1992. Hydrocarbures polyaromatiques dans le sédiment superficiel des côtes ouest de l'Algérie. *Rapp. Comm. int. Mer Médit.*, 33 :184.

SELLALI B., CHOUIKHI A., HOCINI N., YAHI D. et BOUDJELLAL B., 1993. Contamination des sédiments de la côte algérienne par les hydrocarbures polyaromatiques *in* : Circulation des eaux et pollution des côtes méditerranéennes des pays du maghreb. CHOUIKHI *et al.*, (Eds). INOC, Izmir, Turquie; pp. 167 - 169.

L

CHLORINATED HYDROCARBONS IN MUSSELS FROM ALGIERS' BAY

B. SELLALI, S. CHOUAKRI, M. AZZOUZ and B. BOUDJELLAL

ISMAL, Marine Pollution Laboratory,
POBox 90, Algiers 1st. November, 16003 Algeria

Built around a commercial harbour, Algiers is a large metropolitan area with many industries. Urban and industrial wastes are directly discharged in the harbour and the bay (fig. 1). This bay has already been described by many authors (ASSO, 1980 and others). During the winter 1991, two mussels species (*Mytilus galloprovincialis* and *Perna perna*) were selected in order to assess PCBs (arochlors 1254 & 1260), DDT, DDD, DDE, aldrin, gHCH and HCB levels. Two stations are sampled in the harbour (st. 1 & 2) and one at Bordj-el-kiffan (st. 3). A fourth one (st. 4) in Mellah lagoon (east side of Algeria) (fig. 2), is used as a potential reference sector. Analysis is held using GC with electron capture detector, following the UNEP/FAO/IAEA protocole (1982). Intercalibration exercises are made on two reference materials coded 351 and MAB3/OC, (IAEA, Monaco). Hexan extractible organic matter (HEOM) is also estimated in all the samples, in order to see how it is related to the acccumulation of these compounds.

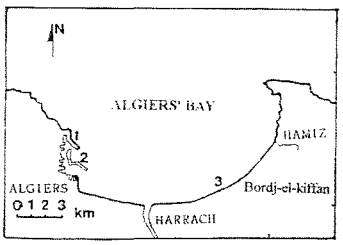


Fig. 1 : Algiers bay; sampling stations.

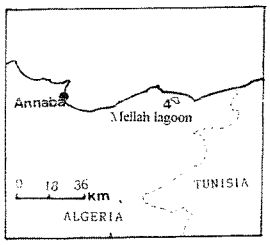


Fig. 2 : Mellah lagoon.

A review of data, expressed in ng/g wet weight, is given in table 1; results in dry weight are shown in fig. 3.

Station	Specie	PCBs	DDTs	Aldrin	γHCH	HCB
1	M.galloprovincialis	51.5	20.2	0.76	0.27	0.05
	P. perna	40.3	13.2	0.21	0.08	0.57
2	M. galloprovincialis	15.5	11.7	0.51	0.30	ND
	P. perna	76.2	28.5	0.70	0.51	0.07
3	M. galloprovincialis	12.2	4.3	0.06	0.16	0.01
4	M. galloprovincialis	4.0	3.0	ND	ND	0.02

Table 1 : Concentrations of chlorinated hydrocarbons (ng/g - wet weight) in the mussels *M. galloprovincialis* and *P. perna*.

In comparison with levels measured by CHOUIKHI *et al.*, 1988 in the same area, concentrations show an increase for PCBs and DDTs in the harbour stations, and are lower in the east side of the bay (st. 3).

As predicted, concentrations detected at Mellah lagoon, which is a protected area, caracterise a reference sector.

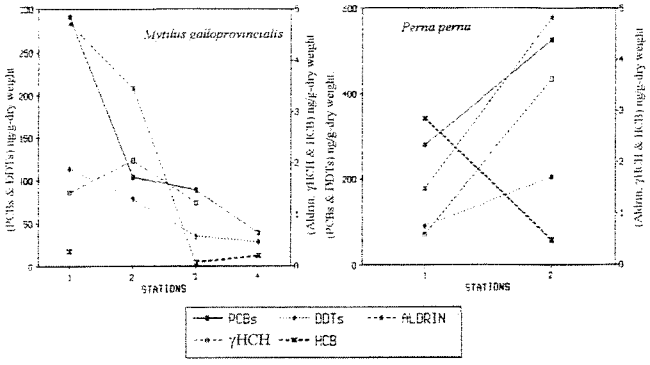


Fig. 3 : Variations of chlorinated hydrocarbons in mussels from Algiers' bay and Mellah lagoon (ng/g- dry weight).

DDTs/PCBs ratios are less than one; this general trend may confirm the predominance of industrial inputs in the study area, where DDT appear to be introduced formerly (AGUILAR, 1984).

Aldrin and HCB are positively correlated to HEOM contents in the mussel *P. perna*. For the other chlorinated hydrocarbons the tendency is similar but not statistically significant. On the other hand, *M. galloprovincialis* presents significant correlations between these chemicals, especially DDT and PCBs, and the percentages of HEOM.

The differences noticed in the accumulation of these compounds between *M. galloprovincialis* and *P. perna* can be attributed to the chronological differences in their reproductive cycles.

REFERENCES

AGUILAR A., 1984. Relationships of DDE/SDDT in the marine Mammals to the chronology of DDT input into the ecosystem. *Can. J. Fish. Aquat. Sci.*, 41 : 840 - 844.

ASSO A., 1980. Etude des métaux lourds chez *Perna perna* (L) dans la région d'Alger. Ve journées Etud. Pollutions CIESM, pp. 163 - 168.

CHOUIKHI A., NACEUR. I et TABTI D., 1988. Niveaux en pesticides organochlorés et en PCBs dans les moules présentes dans la baie d'Alger. *Rapp. Comm. Int. Mer Médit.*, 31, 2 : 142.

UNEP/FAO/IAEA, 1982. Determination of DDTs and PCBs in selected marine organisms by gas-liquid chromatography - References methods for Marine Pollution Studies, n. 14 (rev. 1), 20 p. UNEP.

THE ROLE OF CLAY MINERALS IN TRANSPORT AND ENVIRONMENTAL CAPACITY FOR TRACE METALS

Ivan SONDI[1], Mladen JURACIC[2], and Velimir PRAVDIC[1]

[1] Center for Marine Research, Ruder Boskovic Institute, Bijenicka 54, POB 1016
[2] Department of Geology, Faculty of Science, Univ. of Zagreb, Zvonimirova 8, POB 153, 41000 Zagreb, Croatia

This investigation aims at understanding the ultimate environmental capacity of the estuarine coastal region for selected contaminants. In this sense the role of clay mineral particulates in the transfer of trace metals and radionuclides from land to sea was studied. Field studies were done in the Rasa River estuary (Northern Adriatic), a small karstic river originating in a Eocene flysch region.

Most of the clay minerals are carried by the river sediment in the upper part of the estuary at low water salinity. By sampling estuarine surface sediments segregation of clay minerals was observed with illite preceding the sedimentation of chlorite (SONDI *et al.*, 1994). Such a phenomenon was reported earlier in other estuaries and attributed to different rates of flocculation and flocks sedimentation (EDZWALD and O'MELIA, 1975).

The concentration of Zn, Cu and Mn in clay minerals of the estuarine sediments was found to be three times higher than in the source rocks (Table 1).

Table 1. Surface characteristics and concentration of metals for clays separated from source rock and the surface riverine and estuarine sediments

Sample	SSA ($m^2 g^{-1}$)	ASI (meqv/100g)	Concentration of metals (ppm)						
			Zn	Cu	Pb	Cd	Cr	Mn	Ti
Source rock: 5	56.0	68	67	80	62	2.1	234	104	2594
Riverine sediment: 6	54.1	62	113	141	89	2.5	228	166	2518
Estuarine sediments: 10	48.3	66	216	236	83	2.9	287	393	3805
11	62.5	72	153	127	66	2.4	218	247	2654

Minerals present in the clay fraction (< 1 μm) were exclusively illite, chlorite and smectite.

Table 2 shows results of measurements of the activities of natural 40K, and 137Cs, of sediment samples from the Rasa River and from the estuary. Highest values were obtained in estuarine surface sediments at the river mouth. This is in accordance with the observation that prevalent sedimentation of fine grained particles (clay minerals) occurs in the estuary proper. Previous research already indicated that 40K and 137Cs are strongly associated with fine grained particles, particularly with illite (TAMURA and JACOBS, 1960; FRANCIS and BRINKLEY, 1976).

Table 2. Specific activities (Bq/kg) of 40K and 137Cs in riverine and estuarine surface sediments

Izotop	Riverine sediments*				Estuarine sediments**			
	4	6	7	8	9	10	11	12
^{40}K	516±24	497±23	571±17	674±20	680±18	464±19	470±18	534±21
^{137}Cs	n.o.	14±1	n.o.	n.o.	27±1	25±1	14±1	12±1

n.o. - below the detection limit
** salinity of river waters was < 1 ‰, pH = 7.1*
*** salinity of estuarine waters 36-38 ‰, pH = 7.9 - 8.1*

Field sampling and analysis of sediments corroborated by laboratory experiments (SONDI *et al.*, 1994) indicates that the accumulation of heavy metal contaminant is probably the result of two concurrent processes :

1. Flocculation followed by fast sedimentation;
2. Strong adsorption of heavy metals to clay minerals due to their specific surface physico-chemical properties.

REFERENCES

EDZWALD, J.K. and O'MELIA, C.R., 1975. Clay distributions in recent estuarine sediments. *Clays Clay Minerals*, 23 : 39-44.

FRANCIS, C.W. and BRINKLEY, F.S., 1976. Preferential adsorption of 137Cs to micaceous minerals in contaminated freshwater sediments. *Nature*, 260 : 513-519.

SONDI, I., JURACIC, M., PROHIC, E. and PRAVDIC, V. 1994. Particulates and the environmental capacity for trace metals. A small river as a model for a land-sea transfer system : The Rasa River estuary. *Science of the Total Environment*, 155 : 173-185.

TAMURA T. and JACOBS D.G. 1960. Structural implications in caesium sorption. *Health Phys.*, 2 : 391-398.

SIMULATION MODEL OF A COASTAL ECOSYSTEM INFLUENCED BY EUTROPHICATION

G. TSIRTSIS

Depart. of Environmental Studies, Univ. of the Aegean, 17 Karadoni str. Mytilini, Greece

The integration of the complex processes occuring in physical systems is being carried out nowadays using simulation models (FASHAM *et al.*, 1990). Such an approach to describe the dynamics of a coastal ecosystem influenced by eutrophication, caused by sewage effluents, is attempted in the present work. The modelling effort is focused on the interactions between phytoplankton, heterotrophic bacteria and organic matter, with less emphasis on the phytoplankton-nutrient interrelationship. The physical system is located along the coastal area of the city of Mytilini. Physical, chemical and biological data have been collected from two stations, the first one characteristic of eutrophication, and the other one of oligotrophy. Sampling details and the analytical methodology have been given in previous work (KARADANELLI *et al.*, 1992). Two spatial compartments were defined in the model, the eutrophic receiving the sewage effluents and the oligotrophic located offshore. Interactions between the two compartments are permitted using a turbulent exchange coefficient. Physical forcing from temperature and solar radiation have also been considered. The flow diagram is presented in Figure 1.The state variables of the model are phytoplanktonic and bacterial carbon, ammonia, nitrate and dissolved organic carbon concentrations. Nitrogen was chosen for the description of the energy flow since it is recognized as the primary limiting nutrient for algal productivity in coastal waters (BLACKBURN & SORENSEN, 1988). The key processes to be modelled are photosynthesis, driven by the physical forces of solar radiation and temperature, phytoplanktonic exudation, bacterial growth and organic matter mineralization. The flow diagram inside the eutrophic compartment is presented in Fig.2. The model was run until steady-state using the Runge-Kutta fourth-order integration algorithm for the solution of the differential equations, with a time step of one day. The annual cycles of phytoplanktonic and bacterial biomass as well as the ammonia and dissolved organic carbon concentrations in the eutrophic compartment are presented in Fig. 3 and 4.

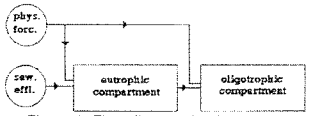


Figure 1. Flow diagram for the spatial compartments of the model.

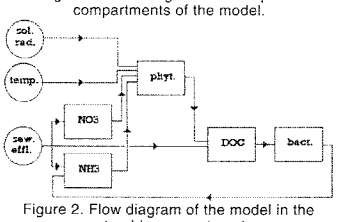


Figure 2. Flow diagram of the model in the eutrophic compartment.

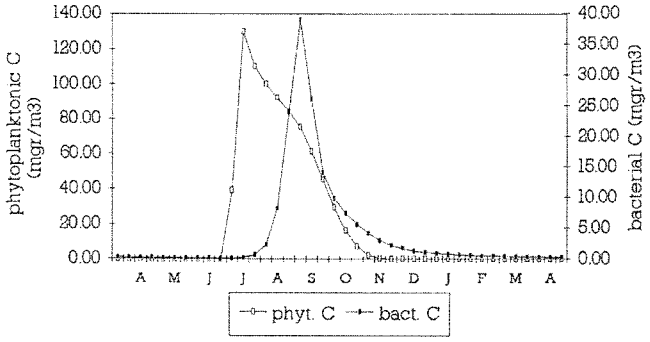


Figure 3. Annual cycles of phytoplanktonic and bacterial biomass in the eutrophic compartment.

A general pattern of low values in winter and very high in summer for phytoplanktonic and bacterial biomass was predicted by the model, in good agreement with the observed data. The bacterial peak in September can be attributed to the high concentration of dissolved organic matter, resulting from the degradation of phytoplanktonic products.

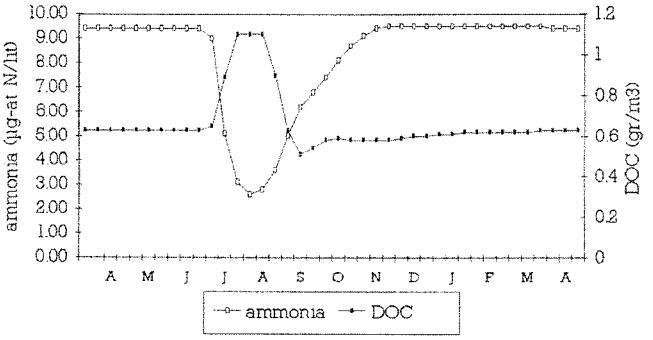


Figure 4. Annual cycles of ammonia and DOC concentrations in the eutrophic compartment.

High concentration of ammonia is predicted by the model, in accordance to the observed data, due to the input from the sewage outfalls. Almost the same patterns, for the annual cycles of the state variables, were observed for the oligotrophic compartment, but the values were much lower. An attempt was made to model the dynamics of a coastal ecosystem influenced by eutrophication. A better parameterization is being carried out using validation data, for further evaluation of the model and its use as a tool for a better understanding of microbial processes.

ACKNOWLEDGEMENTS

The present work was supported by a WHO/UNEP grant (Project ICP/CEHO42).

REFERENCES

BLACKBURN T.H. and SORENSEN J., 1988. Nitrogen Cycling in Coastal Marine Environments. J. Wiley and Sons, New York.

FASHAM M.J.R., DUCKLOW H.W. and McKELVIE S.M., 1990. A nitrogen based model of plankton dynamics in the oceanic mixed layer. *Journal of Marine Research*, 48 : 591-639.

KARADANELLI M., MORIKI A., FARIDIS E. and KARYDIS, M., 1992. Annual pattern of heterotrophic bacteria and phytoplankton (...). *Rapp. Comm. Int. Mer. Médit.* 33 : 198.

LEVELS OF ORGANOCHLORINES IN RED MULLET FROM GREEK WATERS

V. VASSILOPOULOU, R. PSYLLIDOU-GIOURANOVITS and E. GEORGAKOPOULOU-GREGORIADOU

National Centre for Marine Research, Hellinikon 16604, Greece

Organochlorine concentrations data in the tissues of red mullet (*Mullus barbatus*), a quite abundant and commercially important fish species, have been the subject of several studies during the last decade (RAVID *et al.*, 1985; SATSMADJIS *et al.*, 1988a; GEORGAKOPOULOS-GREGORIADES *et al.*, 1991; VASSILOPOULOU and GEORGAKOPOULOS-GREGORIADES, 1993). The aim of the present study is to report on the concentrations of organochlorines in red mullet caught at five sites of the Greek Seas, in spring and autumn from 1989 to 1991.

Figure 1. Location of sampling stations.

Sampling locations appear in Figure 1. In each specimen the fork length, weight, sex and state of maturity were recorded. Then, the flesh of the fish was removed, lyophilized, ground, mixed and stored in a refrigerator till used for further analysis. The organochlorine and lipid concentrations in the flesh of red mullet was determined according to the procedure proposed by SATSMADJIS and LATRIDES (1985) as modified by SATSMADJIS *et al.*, (1988b).

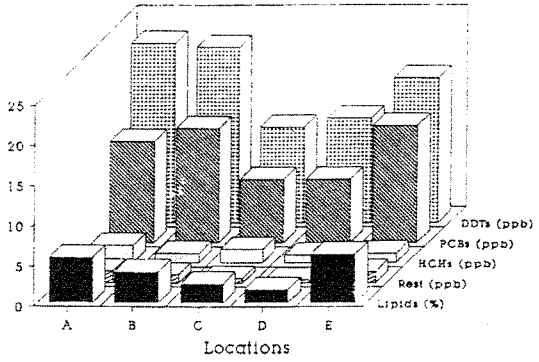


Figure 2. Mean total values of organochlorines and lipids.

Complementary clustering (group average stratery) using the Bray-Curtis similarity coefficient (BRAY and CURTIS, 1957) were performed on mean organochlorine data at the five sampling locations, using Primer algorithms (CLARKE and WARWICK, 1989). The mean total values of organochlorine concentrations (ppb wet weight) and the mean percentage of lipids in the red mullets were in all sites rather low (Fig. 2). Both parameters exhibited minimum values at sites C and D (located at the southern part the Greek Seas), which could be also influenced by the fact that specimens from sites C and D were of smaller size than those from the other three areas (t-test, P>0.05). It is known that organochlorines are lipophilic pollutants, whose concentrations generally increase as fish grow (LARSSON *et al.*, 1991; VASSILOPOULOU and GEORGAKOPOULOS-GREGORIADES, 1993). The application of cluster analysis revealed that sites A, B (NE Greece) and site E (NW Greece) exhibiting higher organochlorine concentrations, clustered together (Fig. 3). Sites C and D formed a separate group. Hence, higher organochlorine concentrations, being consistent with lipid content and size of fish, appear in mullets from the northern part of Greece in relation to those from the southern part. The organochlorine concentration pattern reported for the same sites for the period 1986-88 (GEORGAKOPOULOS-GREGORIADES *et al.*, 1991) revealed an east-west decline in organochlorine levels. The difference between the two surveys seems to be created by changes in organochlorine levels arising from the different lipid content and size of fish rather than real changes in organochlorine levels in the sampling sites.

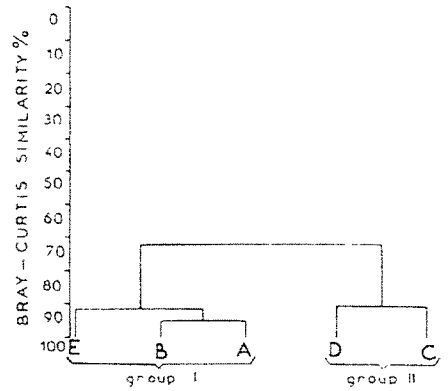


Fig. 3. Dendrogram for the mean concentrations of organochlorines in red mullet from 5 Greek locations

REFERENCES

BRAY, J. R. & CURTIS, J. T., 1957. *Ecol. Monogr.* 27 : 325-349.

CLARKE, K. R. & WARWICK, R. M., 1989. FAO/IOC/UNEP, Part II, 85p.

GEORGAKOPOULOS-GREGORIADES *et al.*, 1991. *Mar. Pollut. Bull.*, 22 : 237-241.

LARSSON *et al.*, 1991. *Environ. Pollut.*, 69 : 39-50.

RAVID *et al.*,1985. *Mar. Pollut. Bull.*, 16 : 35-38.

SATSMADJIS, J. & Iatrides, B. (1985). *Centro.* 1 : 57-66.

SATSMADJIS *et al.*, 1988a. *Mar. Pollut. Bull.*, 19 : 136-138.

SATSMADJIS *et al.*, 1988b. *J. Chromatogr.*, 437 : 254-259

VASSILOPOULOU, V & GEORGAKOPOULOS-GREGORIADES, E., 1993. *Mar.Pollut. Bull.*

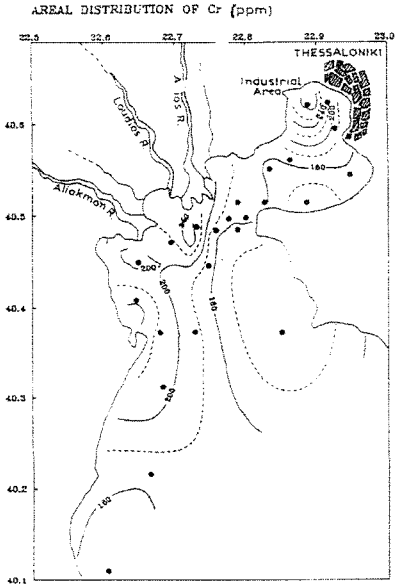
L

GEOCHEMICAL ASPECTS OF A GULF INFLUENCED BY ANTHROPOGENIC ACTIVITIES (THERMAIKOS GULF, N.W. AEGEAN SEA)

F. VOUTSINOU-TALIADOURI, E. GEORGAKOPOULOU-GREGORIADOU & R. PSYLLIDOU-GIOURANOVITS

National Centre for Marine Research, 166 04 Hellinikon, Hellas

Thermaikos Gulf, in the N.W. Aegean Sea, receives about 120,000 m^3/day of untreated sewage water from the city of Thessaloniki, with a population of 1,200,000 inhabitants. Also, an amount of about 25,000 m^3/day of treated or partially treated industrial effluents is released on the northwestern coast of the bay, where the industrial zone is located. On the west side of Thermaikos Gulf, the rivers Axios, Loudias and Aliakmon release important amounts of some metals to the sea. The main interest of the present study is to assess the environmental state of the region, as far as the heavy metal levels is concerned, after the removal of the 30% of the sewage discharges via the newly constructed outfall. It is also to compare the status of the marine environment 20 years after the first investigations.



Surface sediment samples recovered from Thermaikos Gulf during 1993 over a grid of 24 stations were examined for grain composition, organic carbon and the metals Fe, Cr, Ni, Mn, Zn Co, Cu and Pb. The samples were taken using a 0.1m^2 van Veen grab. 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 305B A. A. S. (SATSMADJIS & VOUTSINOU-TALIADOURI, 1981). The particle size composition was estimated according to BUCHANAN's technique (1971). The 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 (‰) 0.85, 4.4; Mn (mg/kg) 38, 5.0; Zn (mg/kg) 4.3, 7.2; Cr (mg/kg) 3.8, 3.4; Ni (mg/kg) 3.3, 4.1; Co (mg/kg) 0.9, 8.2; Cu (mg/kg) 1.1, 4.8; Pb (mg/kg) 0.8, 6.7.

The cold dilute HCl extraction method is chosen because it will release both inorganic and organic associated non-residual heavy metals from sediments without materially affecting the silicate matrix (DUINKER *et al.*, 1974). The analysis of the non-residual (non-lattice held) elements will often yield more data on the extent of heavy metal pollution than will that of the total sediment which include the residual or non-polluted fraction. Non-residual heavy metals are not part of the silicate matrix and have been incorporated into the sediment from aqueous solution by processes such as adsorption and organic complexation, i.e. non-residual heavy metals include those originating from polluted waters (CHESTER & VOUTSINOU, 1981). The analyses of the data reveals that most of the Thermaikos Gulf seafloor is covered by fine sediment, which is derived mainly from the Rivers Axios, Loudias and Aliakmon and containing relatively high amounts of heavy metals. The elements studied can be divided into two categories : the ones derived mainly from anthropogenic activities and the others which are probably depended on natural geochemical processes. More specifically, the main sources of organic carbon and Cu, Pb, Zn, Cr (Fig. 1) are the Thessaloniki sewage and industrial outfalls and the Axios river. Nickel, Co, Fe and Mn have mostly a natural origin, being derived from the weathering of mafic and ultra-mafic rocks, largely extended on the adjacent land (VOUTSINOU-TALIADOURI & VARNAVAS, in press).

Table 1: Heavy metal concentrations of the present study, together with those reported in the past (10 and 20 years ago).

	Fe %	Cr ppm	Ni ppm	Mn ppm	Zn ppm	Co ppm	Cu ppm	Pb ppm
Present Study	1.94-3.14	121-294	60-224	463-1935	73-203	13-30	17-51	20-150
Study of '85*	-	66-390	55-290	215-1340	32-1610	14-37	8-170	11-330
Study of '75**	-	102-353	52-240	347-2050	45-280	12-42	11-82	13-230

** VOUTSINOU-TALIADOURI, F. & LEONDARIS, S.N.*
*** CHESTER, R. & VOUTSINOU, F.G. After the modification with a factor which equilibrates the two extraction techniques.*

Table 1 gives the results obtained from this study, as well as results obtained with the same methodology 10 and 20 years ago. As it can be seen, the heavy metal ranges do not have changed during the 20 last years. The relatively higher maximum values of the non-residual heavy metals (Cr, Zn, Cu and Pb) observed in the study of '85 are mainly due to the fact that the sampling stations in that study were closer to the pollution sources.

REFERENCES

BUCHANAN J.B., 1971. Sediments, *in* : Methods for the study of marine benthos, ed. by N.A. Holme & A. McIntyre, IBP Handbook n°16. Oxford University Press, Oxford, pp. 35-39.
CHESTER R. & VOUTSINOU F.G., 1981. The Initial Assessment of Trace metal Pollution in Coastal Sediments. *Mar. Pollut. Bull.*, 12 : 84-91.
DUINKER J.C., VAN ECK G.T.M. & NOLTIN, R.F., 1974. On the behaviour of copper, zinc, iron and manganese and evidence for mobilization processes in the Dutch Wadden Sea. *Neth. J. Sea Res.*, 8 : 214-239.
GAUDETTE H., FLIGHT W., TONES I. & FOLGER D., 1974. An inexpensive titration method for the determination of organic carbon in recent sediments. *J. Sedim. Petrol.*, 44 : 249-253.
IAEA., 1978. Intercalibration of analytical methods on marine environmental samples. Progress Report n°18.
SATSMADJIS J. & VOUTSINOU-TALIADOURI F., 1981. Determination of trace metals at concentrations above the linear calibration range by electrothermal atomic absorption spectrometry. *Anal. Chim. Acta*, 131: 83-90.
VOUTSINOU-TALIADOURI F. & LEONDARIS S.N., 1986. An assessment of metal Pollution in Thermaikos Gulf, Greece. *Rapp. Comm. int. mer Médit.*, 30 : 2:43.
VOUTSINOU-TALIADOURI F. & VARNAVAS S.P., 1994. Geochemical and sedimentological patterns in the Thermaikos Gulf, N.W.Aegean Sea, ... *Estuar., Coast. and Shelf Sc.*, in press.

ACCUMULATION OF SOME HEAVY METALS IN MARINE POLYCHAETE (*EUNICE APHRODITOIS*) AND SEDIMENTS OF THE ADRIATIC COAST

I. VUKADIN and N. ODZAK

Institute of Oceanography and Fisheries, Split, Croatia

This paper reports on levels of heavy metals in some marine polychaete (*Eunice aphroditois*) and surrounding sediments from eastern Adriatic coast. Different parts of worms (head, skin and muscle) were examined. Samples were collected at 8 stations in the vicinity of urban centers (Split and Sibenik) where considerable quantities of untreated effluents are discharged and affect significantly the quality of marine ecosystem.

Heavy metals were determined using a double beam AAS, applying a flameless spectrometry. Polychaetes are among the most frequent and abundant marine metazoans in benthic environment. They live in bathyal and abyssal areas, in shelf depths and open coasts in estuaries and in man–made harbours. Today the number of known Eunicadea is about 241 species (FAUCHALD, 1979).

Metal		Head	Skin	Muscle	Sediment	Correlation
Mn	R rsd	0.84-4.73 (2.58)	0.73-6.16 (3.22)	0.41-1.58 (2.25)	99.2-377.9 (0.56)	No
Cr	R rsd	0.49-1.44 (2.21)	0.73-2.29 (4.02)	0.35-1.16 (1.68)	23.6-65.0 (5.27)	No
Ni	R rsd	0.20-0.82 (4.02)	0.31-1.12 (3.05)	0.23-1.17 (1.7)	4.10-14.0 (3.06)	Yes
Pb	R rsd	1.28-37.4 (2.04)	4.00-30.1 (1.26)	2.30-24.9 (1.65)	11.2-67.7 (2.35)	Yes
Cu	R rsd	1.95-11.28 (1.50)	1.70-4.35 (1.31)	0.91-1.68 (1.50)	3.84-11.79 (1.18)	No
Cd	R rsd	0.08-0.29 (2.08)	0.11-0.54 (2.31)	0.14-0.87 (1.77)	0.14-0.74 (7.20)	No
Zn	R rsd	4.46-6.08 (0.95)	6.26-11.87 (0.62)	4.83-8.33 (1.07)	12.92-40.96 (7.40)	No

Table 1. Range of mass concentrations (W_m x 10^6) of heavy metals polychaetes and sediments on investigated areas. (Values in parenthesis are relative standard deviations – rsd).

Despite their obvious importance the literature on ecological roles of these polychaetes, the information about their feeding and biology remains largerly anecdotal. *Eunice aphroditois* is mainly a carnivore. EVANS (1971) found its gut content included annelids, chaetognaths ostracods, copepods, bivalves, a few diatoms and some detritus.

The preliminary results of trace metal concentrations in these worms showed that some of the studied metals are accumulated mainly in head or in skin (Al, Cr, Pb and Cu), whereas others are accumulated in muscle (Zn, Ni).

In our investigation of trace metals in polychaetes and surrounding sediments, where these worms live, we didn't find significant correlations, except for Pb and Ni.

Probably the reason for that is the manner of feeding. This worm is primarily a carnivore, feeding on all kinds of small invertebrates. Spatial distribution of some heavy metal values showed that higher values were recorded in stations with smaller depth or in stations which were situated in an unclosed area (Sibenik). This could be attributed to anthropogenic effects, i.e. to land–based activities.

It is recommended to continue the monitoring of heavy metals concentration in these organisms in order to improve our understanding of their cycling in the marine environment.

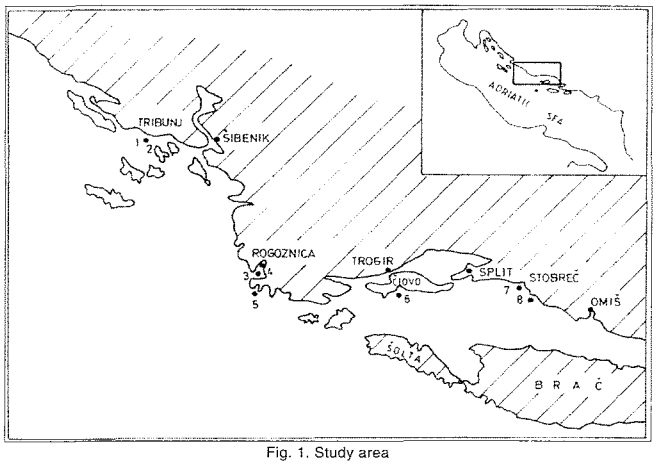


Fig. 1. Study area

REFERENCES

EVANS, S.M., 1971. *Q. Rev. Biol.*, 46 : 379–405
FAUCHALD, N., 1970. Oceanog. *Mar. Biol. Ann. Rev.*, 17 : 193–284.
GHERARDI, M., LEOPORE, E. and SCISCIOLI, M., 1993. *Obelia.*, 19 : 27–45.

ACCUMULATION OF CD, CU AND PB IN THE ZOOPLANKTON OF COASTAL WATERS NEAR LATTAKIA CITY, SYRIA

A.K. YOUSSEF, S. NOUREDDIN & M. BAKER

Marine Research Institute, P.O.Box 2242, Tishreen University, Lattakia, Syria

This study reports on the accumulation of some heavy metals (Cd, Cu and Pb) in some zooplanktonic groups from the Syrian coastal waters near to Lattakia city (Eastern Mediterranean), during the period August 1991 - September 1992.

Copper, cadmium and lead were determined in the coastal waters and some zooplanktonic groups in Lattakia region of the Syrian coast. The study was carried out from February 1991 to October 1992. Seawater and zooplanktonic samples were collected from three stations, along the coast, having different characteristics being directly influenced by riverine, urban and industrial discharges. Station 1 (reference station) is located in front of the Marine Research Institute far from the various sources of pollution in Lattakia city; station 2 is in the entrance of Lattakia harbour, and station 3 at 0.5 mile, approximately, from the Al-Kabir Al-Shimali river estuary. All isolated zooplanktonic groups had been analyzed for these metals, using a digestion method with suprapur nitric acid and employing a Perkin Elmer 2380 Atomic Absorption flame Spectrophotometer.

The heavy metal concentrations in coastal waters ranged between 0.5 to 5.7, 0.09 to 0.8, 0.4 to 2.9 and 0.4 to 0.9 ug/l for Cu, Cd, Pb and Zn respectively. The study shows variations in the concentrations of these metals depending on the different characteristics of each station.

The metal levels in copepods (most abundant zooplanktonic group) were between 5.0 to 103.0 and 0.0 to 217.0 ug/g dry weight for Cu and Pb respectively. The concentration of Cd in copepods ranged between 0.0 and 4.7 ug/g dry weight in 90% of samples, with the rest 10% showing higher values (see table).

The analysis of other zooplanktonic groups : herbivores (pteropods and larva of crustaceans) and carnivores (chaetognaths and isopods) show, relatively, lower values for the same metals, and hence are of lesser significance.

Date	Station 1			Station 2			Station 3		
	Cd	Cu	Pb	Cd	Cu	Pb	Cd	Cu	Pb
26.08.1991	ND	16	8	ND	30	19	ND	ND	124
16.10.1991	ND	5	ND	ND	4	ND	ND	12	6
30.04.1992	ND	40	ND	ND	ND	ND	ND	19	ND
26.05.1992	NM	NM	NM	ND	8	54	ND	103	103
04.07.1992	51	5	102	5	6	47	2	27	14
05.08.1992	91	45	ND	3	24	28	ND	85	ND
10.09.1992	ND	95	57	ND	39	63	ND	64	217

ND: Not Detected *NM: Not Measured*

Table 1: Cd, Cu and Pb concentrations of copepod samples (ug/g dry weight) collected from Syrian coastal waters near Lattakia city.

This work was carried out in the framework of MED POL and a MED TRUST FUND contribution was received through the FAO of the United Nations (SYR/2).

L

M

COMITÉ MICROBIOLOGIE ET BIOCHIMIE MARINES

Président : Evelyne RICHELLE-MAURER
Vice-Président : Jacques SEMERIA

IMMUNOFLUORESCENT PROBES TO STUDY THE DIVERSITY OF MARINE PICOPHYTOPLANKTON COMMUNITIES OF THE MEDITERRANEAN SEA

ACOSTA POMAR M.L.C.[1], CARUSO G.[2], MAUGERI T.L[1]. and ZACCONE R.[2]

[1] Dipart. di Biologia Animale ed Ecologia Marina, Salita Sperone 31, S. Agata, Messina, Italy
[2] Istituto Sperimentale Talassografico, Spianata S. Raineri, 98100 Messina, Italy

Cultural methods may underestimate the abundance of bacteria present in natural samples. Direct counts by epifluorescence microscope utilizing specific DNA probes (fluorochrome as DAPI and AO) are more useful methods to enumerate the marine bacterial populations. The numbers obtained by direct microscopic method exceed plate counts by 2 to 3 orders of magnitude. But this method is not specific since most marine bacterial cells appear similar under epifluorescence microscope.The indirect immunofluorescence (IIF) may be a specific approach to know the species composition of marine microbial communities. We used IIF technique to demonstrate the presence of fecal indicators as *E.coli* (ZACCONE *et al.*, in press) and *Salmonella strains* (MAUGERI *et al.*, 1992a).

The presence of the picophytoplankton in sea water samples - the autofluorescent cells of picoplankton - has been recognized by the epifluorescence microscope. It represents an important fraction of plankton even if its quantity and quality are highly variable. In many regions of the oceans prokaryotic cells (cyanobacteria) outnumber the eukaryotic cells by approximately an order of magnitude. Cyanobacteria at epifluoresecence appear yellow orange, eukaryotic cells red (MAUGERI *et al.*,1992b); *Synechococcus* is the genus more studied fluorescence microscope appear yellow-orange, eukaryotic cells red; the species of this genus can be distinguished by the different prevailing pigment. Different clones contain, phycoerythrin (PE) and phycocyanin (PC) dominant pigments. Autofluorescence has been used successfully to identify and enumerate PE-containing strains. By this method the PC-containing cyanobacteria are not distinguishable. Specific sera labelled with fluorescein isothiocyanate has been proposed to identificate and enumerate marine chroococcoid cyanobacteria (CAMPBELL *et al.*,1983; CAMPBELL,1987). Results of a preliminary survey of the distribution and population density of picophytoplankton in the coastal waters surrounding Messina were presented in a previous paper (MAUGERI *et al.*,1992b).

The fluorochrome DAPI has been used to demonstrate the total number of picoplanktonic cells, the total number of autofluorescing cyanobacteria and two prepared antisera against the cyanobacterial strains from Culture Collection of Marine Phytoplankton, *(Synechococcus* sp. WH 7803,CCMP 1334 and *Synechococcus bacillaris* WH 5701,CCMP 1333, PC-dominant strain and that lacks PE) and the specific abundance of cyanobacterial strains in the surface water samples collected in September 1993 from 18 stations in the Ionian and Tyrrhenian Seas. The used procedures were as described by MAUGERI *et al.* (1992b) and CAMPBELL *et al.* (1983). In the coastal waters of Messina, where urban and industrial wastes are usually dumped, picophytoplanktonic cells ranged between $3.7x10^2$ cells/ml and $2.0\ x10^3$ cells/ml. The abundance of PE-containing (WH 7803) ranged from 4.1x10 cells/ml (stations a, j and m) to $1.3x10^3$ cells/ml(st c), whereas the PC-containing *S. bacillaris* ranged from 1.4x10 (st c and e) to $6.7x10^2$ cells/ml (st b) in the examined samples. Fig. 1 shows the abundance of cyanobacterial cells. Fig. 2 shows the concentration of two cyanobacterial serogroups tested by IIF. The IIF showed only a few cross reactions in *Synechococcus* genera (ZACCONE *et al.*, 1994). These are the first existing data on the distribution of specific serogroups of picophytoplanktonic cyanobacteria in the Mediterranean sea. These data show a correlation with water temperature and emphasize the seasonal studies to define factors that could control or influence the serogroup distribution. The low numbers of strains specific by IFF demonstrate that this method is of limited use in quantifying functional groups of microorganisms but that it provides specific information on the diversity of natural populations and their relation to culturable strains of bacteria and cyanobacteria.

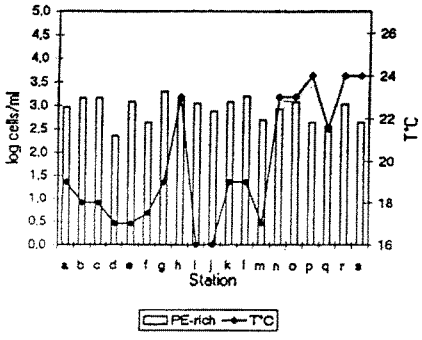


Fig 1.

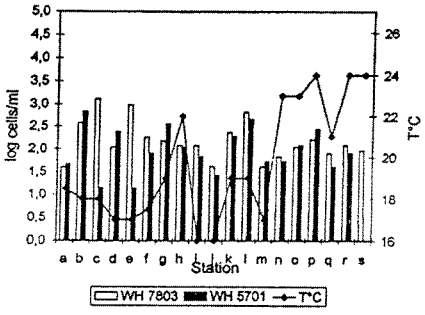


Fig 2.

REFERENCES

CAMPBELL L., CARPENTER E.J., JACONO V.J., 1983. Identification of Chroococcoid cyanobacteria by immunofluorescence. *Appl. Environ. Microbiol.*, 46 : 553-559.

CAMPBELL L., 1987. Identification of marine coccoid cyanobacteria by immunofluorescence. *In* : Yentsch C.M. and Mague F. (eds) Immunochemical approaches to estuarine,coastal, and oceanographic questions, coastal and estuarine lectures series XXX Springer, Berlin.

MAUGERI T.L., ZACCONE R., CARUSO G., CRISAFI E., GUGLIANDOLO C., 1992a. Examen de la qualité de l'eau de mer par immunofluorescence. *Rapp. Comm. int. Mer Médit.*, 33 : 199.

MAUGERI T.L., ACOSTA POMAR M.L.C., BRUNI V., SALOMONE L., 1992b. Picoplankton and picophytoplankton in the Ligurian Sea and Straits of Messina (Mediterranean Sea). *Botanica Mar.*, 35 : 493-502.

ZACCONE R., CRISAFI E., CARUSO G., in press. Evaluation of fecal pollution in coastal waters by immunofluorescence. *Mar. Microbial Food Webs* .

ZACCONE R., ACOSTA POMAR M.L.C., CARUSO G., FEMINO' A., MAUGERI T.L., 1994. Immunofluorescence of *Synechococcus* spp. by epifluorescence and scanning laser microscopes. VIII International Symposium on Phototrophic Prokaryotes, Urbino, 10-15 September, Abstracts : 131.

ESTIMATION DU RÔLE DU PLANCTON SUR LE TAUX D'AMMONIFICATION DANS LES SÉDIMENTS

R. BARATIÉ[1], M. BOISSON[2], J.C. BRACONNOT[1], S. DALLOT[1], F. FERNEX[1]

[1] Observatoire Océanologique, U.R.A. CNRS; 06230- Villefranche/Mer, France
[2] Office Monégasque de l'Environnement, Fontvieille, Principauté de Monaco

Lors du précédent congrès de la CIESM, nous avons présenté des résultats relatifs à l'étude pluridisciplinaire d'un site de la Méditerranée nord-occidentale : le point B près du Cap Ferrat, où les fonds atteignent 80 à 90 m (BOISSON *et al.*, 1992). Nous constations que, au printemps 1988, la biomasse phytoplanctonique avait augmenté jusqu'à la fin avril et diminué ensuite jusqu'à la fin de l'été. La population de salpes, elle, s'était développée à partir de la fin du mois de mars et avait atteint son maximum entre le 15 et le 20 mai; elle était devenue quasi nulle dès la fin du mois de juillet. La concentration en N particulaire dans le sédiment superficiel au même point était la plus élevée en juin, très peu de temps après le maximum du taux d'ammonification, qui, lui, a eu lieu à peu près en même temps que le maximum de la population des salpes. Nous avions déduit de ces observations que les salpes, s'étant nourries du phytoplancton, l'avaient consommé jusqu'à presque l'épuiser. La réduction de la biomasse phytoplanctonique avait dû entraîner l'extinction de la population des salpes. Nous avions présenté un modèle mathématique qui exprimait que la réduction de la masse phytoplanctonique avait été due aux seules salpes, sans tenir compte d'une population de copépodes qui s'était développée en avril et avait évidemment contribué à la diminution de la biomasse phytoplanctonique. Par ailleurs, il est probable que les salpes ne se sont pas seulement nourries de phytoplancton, mais aussi de pelotes fécales de copépodes (et de bactéries développées aux dépens de pelotes fécales).

En 1987, les populations planctoniques, plus abondantes, s'étaient succédées à peu près de la même façon. Exprimée en azote, la masse phytoplanctonique atteignait à la fin mars 1987 0.29 µatg N/l. En avril, un pic de copépodes correspondait à 11000 individus/m^3, soit 0.6 µatg N/l. A la fin mai, la concentration en salpes atteignait son maximum avec 0.2 µatg N/l. Nous avons mesuré les plus fortes concentrations en N organique dans le sédiment superficiel et les plus forts taux de destruction de l'azote organique (ammonification) à la fin juin, respectivement 0.8 mg N g^{-1} et 0.05 µM cm^3j^{-1}. La quantité de copépodes et celle de salpes étaient négligeables en juillet. L'introduction du développement des copépodes dans le modèle en modifie la formulation, en particulier dans la première équation qui exprime les conditions déterminant la croissance de la masse phytoplanctonique. Et, bien entendu, une équation supplémentaire doit exprimer les conditions qui permettent le développement de la masse des copépodes; l'équation relative aux salpes devra exprimer que ces organismes s'étaient en partie nourris de pelotes fécales de copépodes.

$$(1)\quad \frac{d\mathbf{P}}{dt} = L(N)\,\mathbf{u}\,\mathbf{P} - m_p\,\mathbf{P} - I_c\,\mathbf{C}\,(1 - \exp(-(k_c(\mathbf{P} - P_0)))) - I_s\,S\,\mathbf{P}/(\mathbf{P}+\mathbf{R})$$

P : biomasse phytoplanctonique, exprimée en µM(N) l^{-1}.
R : stock de pelotes fécales présentes dans l'eau (disponibles pour les salpes)

$L(N) = \frac{\mathbf{N}}{n+\mathbf{N}}$, avec n = 1.5 µatg N l^{-1}, concentration "optimale" en nutriments azotés, **N** : concentration en nutriments azotés (ANDERSEN et NIVAL, 1988).

u : fonction dépendant des concentrations en o-P, Silice, de l'irradiance, etc.
mp : mortalité du phytoplancton (j^{-1}). I_c : coefficient d'ingestion par les copepodes (j^{-1})
C : concentration en copépodes. P_o: concentration limite en dessous de laquelle le développement de la population des copépodes n'est plus possible (= 0.07)

La production primaire (2) $\mathbf{pp} = \frac{\mathbf{N}}{1.5+\mathbf{N}}\,\mathbf{u}\,\mathbf{P}$

Le développement de la biomasse des copépodes peut s'écrire:

$$(3)\quad \frac{d\mathbf{C}}{dt} = a_c\,I_c\,\mathbf{C}\,(1 - \exp(-k_c(\mathbf{P}-P_o)) - m_c\,\mathbf{C} - h_c\,\mathbf{C}$$

a_c: coefficient déterminant la part de phytoplancton assimilée par les copépodes par rapport à la part ingérée par les copépodes; $a_c\,I_c = 0.3$ or 0.31 j^{-1}.
k_c = facteur d'ajustement (l (µatg N)$^{-1}$).
h_c : coefficient d'excrétion; m_c : coefficient de mortalité; $(m_c + h_c) = 0.18\ j^{-1}$.
Les pelotes fécales produites par les copépodes :

(4) $\mathbf{r} = (I_c - a_c I_c)\,\mathbf{C}$

Le stock de pelotes fécales disponible pour les salpes :

$$(5)\quad \mathbf{q}(t+dt) = \mathbf{P}(t+dt) + \sum_0^t (i\,\mathbf{r} - I_s(\frac{\mathbf{q}}{\mathbf{q}+\mathbf{P}})S)$$

i : facteur de proportionalité exprimant la portion de pelotes de copépodes disponible pour les salpes. I_s: coefficient d'ingestion des salpes (j^{-1}) (à déterminer).

L'équation définissant le développement de la population de salpes devient:

$$(6)\quad \frac{dS}{dt} = a_s I_s\,(1 - \exp(-k_s(\mathbf{q}-qo)))\,\mathbf{S} - (m_s + hs)\,\mathbf{S}$$

En utilisant les valeurs mesurées au point B complétées par des valeurs fournies par la littérature, on peut calculer un taux d'ingestion pour les salpes $I_s = 0.8\ j^{-1}$, et un taux d'assimilation $a_s I_s = 0.48\ j^{-1}$. On peut admettre que seule une partie de l'azote organique du sédiment ($\mathbf{N_m}$) est rapidement minéralisable en ammoniaque et que le taux de transformation au jour t est proportionnel à la concentration en azote minéralisable 10 jours avant. Le coefficient calculé est $K_N = 1.3x10^{-4}\{\mathbf{N_{m(t-10)}}\}j^{-1}$. Une formulation semblable à celle présentée en 1986 (BARATIÉ *et al.*,1986) permet d'évaluer le taux de nitrification, avec un taux maximum RN= 0.47 µM $cm^{-3}j^{-1}$.

Ce modèle conduit à une estimation de la production primaire destinée à répondre à l'action des herbivores. Le maximum calculé (950 mg C $m^{-2}j^{-1}$) est environ 2 fois plus élevé que celui trouvé par d'autres auteurs pour le même secteur (BROUARDEL et RINK, 1963; RODRIGUEZ-PRADA, 1973). Le résultat apparemment trop élevé du calcul peut signifier que les copépodes utilisent pour leur nourriture non seulement le phytoplancton mais aussi des bactéries et (ou) du nanozooplancton. Il faudrait prendre en compte le développement microbien, mais les données sont actuellement fragmentaires.

RÉFÉRENCES

ANDERSEN V. et NIVAL P., 1987. *Oceanologica Acta*, n° sp : 21-217.

BARATIE R., FERNEX F., MOUREAU Z. et STEVENINO R.M., 1986. *Rapp. Comm. int. Mer Médit.*, 30/2 : 258.

BOISSON M., BRACONNOT J.C, FERNEX F., MARMENTEAU C., MOITIE M. et PUCCI R., 1992. *Rapp. Comm. int. Mer Médit.*, 33 : 195.

BROUARDEL J. et RINK E., 1963. *Ann. Inst. océanograph.*, 40 : 109-164.

RODRIGUEZ-PRADA F., 1973.- Th. 3C, Univ. Paris VI (Stat. zool. Villefranche); 86 p.

M

FLUX IONIQUES ET TRANSPORT DU BICARBONATE À TRAVERS LES FEUILLETS ÉPITHÉLIAUX DU TENTACULE D'*ANEMONIA VIRIDIS* (FORSSKÅL, 1775)

Sylvie BÉNAZET, Denis ALLEMAND, Jean JAUBERT

Centre Scientifique de Monaco, Observatoire Océanologique Européen, Principauté de Monaco

Chez les Cnidaires anthozoaires, le cœlenteron est séparé de l'eau de mer externe par un tissu composé de deux couches épithéliales : un ectoderme en contact avec le milieu extracœlentérique et un endoderme en contact avec le milieu intracœlentérique. Les deux feuillets sont séparés par une couche de mésoglée. La communication entre le cœlenteron et l'eau de mer externe se fait par l'intermédiaire d'un orifice unique "bouche" dont l'ouverture est assurée par des muscles. Deux hypothèses concernant le renouvellement du liquide cœlentérique sont envisageables : soit une aspiration/expulsion d'eau par la bouche, soit des systèmes de transport transépithéliaux. Dans le but de caractériser les propriétés du tissu oral des Cnidaires, nous avons utilisé comme modèle d'étude le tentacule de l'anémone de mer *Anemonia viridis* (FORSSKÅL, 1775). Les 150 à 200 tentacules peu rétractiles de cette espèce méditerranéenne peuvent atteindre 15 cm de longueur. Le protocole expérimental choisi pour l'étude des transports ioniques est le suivant : une partie du tentacule est découpée dans le sens de la longueur, puis placée à l'intérieur d'une chambre de Ussing. La chambre de Ussing est constituée de deux hémichambres d'un volume unitaire de 200 µl. La surface utile exposée est de 0,2 cm^2 soit une quantité de protéines de 1,13 ± 0,068 mg. Des expériences de cinétique isotopique avec du calcium (^{45}Ca), du sodium (^{22}Na) et du chlore (^{36}Cl) ont permis de déterminer les propriétés de perméabilité des feuillets épithéliaux. L'eau de mer contenant le radioisotope est placée dans une hémichambre et l'apparition de la radioactivité est suivie en fonction du temps dans l'hémichambre opposée. L'action du cyanure 1 mM, inhibiteur des transports actifs, a été testée afin de caractériser le type de transport. Les flux entrant (c-à-d. du milieu extratentaculaire vers le milieu intratentaculaire) et sortant (c-à-d. du milieu intratentaculaire vers le milieu extratentaculaire) ont été déterminés de même que le flux net résultant de la différence entre le flux entrant et le flux sortant. Pour chaque ion testé, les valeurs du flux entrant sont superposables aux valeurs du flux sortant, le flux net est donc nul. Les valeurs des flux entrants sont reportées dans le tableau 1.

Ion	Flux entrant (nmol. $min^{-1}.cm^{-2}$)	Flux entrant (nmol. min^{-1}.mg Protéines^{-1})
Ca^{2+}	5 ± 0,45	0,88 ± 0,08
Na^{+}	540 ± 20	95,58 ± 3,54
Cl^{-}	1000 ± 200	176,99 ± 35,4

Tableau 1

Les flux sont insensibles au cyanure ce qui suggère que les ions cheminent par simple diffusion en empruntant une voie de passage paracellulaire. Dans ces conditions les coefficients de perméabilité ont pu être déterminés d'après la relation : $J_d = A.C.P_d$ où A est la surface membranaire, C la concentration et Pd le coefficient de perméabilité. Les valeurs des coefficients de perméabilité sont reportées dans le tableau 2.

Ion	Coefficient de perméabilité (10^{-5} cm. s^{-1})
Ca^{2+}	10
Na^{+}	11
Cl^{-}	2,45

Tableau 2

Ces valeurs de perméabilité comparées à celles obtenues pour d'autres épithéliums permettent de classer le tissu du tentacule d'*Anemonia viridis* parmi les épithéliums de type lâche. Un autre aspect de ce travail a consisté en l'étude du transport des ions bicarbonate à travers les feuillets du tentacule. Les cellules endodermiques contiennent en effet des dinoflagellés *Symbiodinium* sp. (FREUDENTHAL, 1962) communément appelés zooxanthelles (TRENCH, 1981). Ces zooxanthelles sont entourées d'une membrane vacuolaire d'origine animale (SMITH et DOUGLAS, 1987). Pour assurer leur taux maximal de photosynthèse, les zooxanthelles ont besoin de gaz carbonique. Le CO_2 fourni par la respiration des cellules animales et des cellules végétales (1,67 ± 0,2 nmol O_2. min^{-1}. mgProtéines^{-1}) ne suffit pas à alimenter la photosynthèse qui produit 7,19 ± 1,13 nmol O_2. min^{-1}. mgProtéines^{-1} à une intensité lumineuse de 300 µmol. m^{-2}. s^{-1}. Les zooxanthelles doivent donc utiliser une autre source de carbone inorganique (C_i). Dans l'eau de mer le CO_2 dissous n'est présent qu'à la concentration de 10 µM. Le C_i est présent majoritairement sous la forme de bicarbonate (2 mM). Des expériences ont été réalisées dans des eaux de mer avec ou sans bicarbonate. Le tentacule est perfusé pendant 20 min avec le milieu désiré puis placé dans des respiromètres. L'absence de bicarbonate dans le milieu extratentaculaire et intratentaculaire provoque une inhibition de la photosynthèse de 98% par rapport aux conditions de contrôle (eau de mer de part et d'autre). Le bicarbonate est donc la source principale de C_i absorbé par les cellules animales pour être ensuite fourni aux zooxanthelles sous forme de CO_2. En absence de bicarbonate extratentaculaire, l'inhibition photosynthétique est de 67% alors qu'elle n'est que de 37% en absence de bicarbonate intratentaculaire. Ces résultats suggèrent que la source majeure de bicarbonate provient de l'eau de mer extratentaculaire et que le bicarbonate ne diffuse pas à travers les deux couches épithéliales. L'approvisionnement majoritaire en bicarbonate par le milieu extratentaculaire permet de maintenir le pouvoir tampon du milieu intratentaculaire évitant ainsi des variations du pH intratentaculaire qui sont néfastes aux fonctions cellulaires. Plusieurs mécanismes de transport des ions bicarbonate ont été décrits chez les cellules animales. Parmi eux, nous avons testé la présence éventuelle de l'échangeur Cl-/HCO_3- en utilisant un inhibiteur spécifique : le SITS (4-Acétamido-4'-Diisothiocyanatostilbène-2-2'-disulfonic acid). Le tentacule est perfusé dans de l'eau de mer avec ou sans SITS pendant 20 min puis placé dans ces mêmes conditions dans des cuves de mesure de la production d'oxygène. En présence de SITS extratentaculaire et intratentaculaire, l'inhibition est de 65% ce qui montre la présence d'un échangeur de type Cl-/HCO_3-. L'effet du SITS est plus important (50% vs 30%) lorsque l'inhibiteur est placé dans le milieu extratentaculaire que lorsqu'il est placé dans le milieu intratentaculaire. Ces résultats confirment donc que la source majoritaire de bicarbonate provient du milieu extratentaculaire mais aussi que ce bicarbonate emprunte un échangeur anionique vraisemblablement situé sur les membranes des cellules ectodermiques.

RÉFÉRENCES

FREUDENTHAL H. D.,1962. -*Symbiodinium* gen. nov. *Symbiodinium microdriatricum* sp nov., a zooxanthella : taxonomy, life cycle, and morphology. *J. Protozool.* 9 : 45-52.

SMITH D. C. & DOUGLAS A. E., 1987.- Algae in symbiosis II. With marine hosts (animals and protists). *In* : The biology of symbiosis. Willis A. J. & Sleigh M. A. (eds). Edward Arnold, Baltimore. pp 33-46.

TRENCH R. K., 1981.- Cellular and molecular interactions in symbioses between dinoflagellates and marine invertebrates. *Pure & Appl. Chem.*, 53 : 819-835.

MICROBIAL DIVERSITY IN NORTHERN ADRIATIC SEA : PRELIMINARY OBSERVATIONS

S. CARDINALI[1], M. SABEC[1], P. DEL NEGRO[2], P. RAMANI[2]

[1] International Centre for Theorical and Applied Ecologia, Gorizia, Italy

[1] Marine Biology Laboratory, Trieste, Italy

Marine bacteria often dominate the plankton biomass and are responsible for much of the cycling of organic matter. However, bacterial diversity is poorly understood because conventional identification methods neglect about 99% of the organisms (FUHRMAN *et al.*, 1992). Since 1993 a study of microbial diversity has been carried out in the Gulf of Trieste (Northern Adriatic Sea) using different enumeration and identification media. The experimental data obtained have been compared with epifluorescence estimation of bacterial number. A superficial water sample was collected aseptically in May 1993 in a station 300 m offshore in the Gulf of Trieste; 5 ml of the collected sample was filtered on 0,22 µm polycarbonate black membrane (Nucleopore) and stained with 4'6-diamidino-2-phenylindole (DAPI) (PORTER and FEIG, 1980) in order to detect autotrophic and heterotrophic microorgnaisms; the same amount was filtered on 0,22 µm polycarbonate black membrane (Nucleopore) for SEM observations which was carried out after fixing in OsO_4 freeze drying and gold coating. Serial dilutions of the same sample were inoculated (six replicates) by spreading on twelve different media : with or without natural or artificial sea water, with glucose, cellulose or chitin as carbon source (OKAZAKI and OKAMI, 1976; SCHNEIDER and RHEINHEIMER, 1991). In order to evaluate the antrophic contamination total coliforms were detected too. Results are reported on Table.

marine agar	PCA	PCA	PCA	PYA	PYA	PYS	CELL	CHI	MYS	GG	SC
DIFCO	0 NaCl	sw	asw	sw	asw						
200	300	25	50	10	20	20	10	10^3	0	0	0

Table : viable bacteria (CFU/ml) on different media-PCA (Plate count agar), PYA (Pectone yeast extract agar), PYS (Pectone yeast extract salt solution agar), CELL (Cellulose agar), CHI (Chitine agar), MYS (Maltose yeast extract agar), GG (Glycerol glycine agar), SC (starch caseine agar), sw (seawater), asw (artificiaal seawater).

In spite of the absence of coliforms, terrigen contribution was evident, given the hight number of colonies developing on PCA without NaCl and considering that more than half are unable to grow on marine agar. On the other hand, the 75% marine agar growing strains develop in unsalted media. These observation suggest a dominance of bacteria unaffected by NaCl, rather than purely marine bacteria. The geographical position of the Gulf of Trieste with coastal areas densely populated and with inputs of important rivers, as Isonzo and Tinavo, may explain the situation observed (DEL NEGRO *et al.*, 1993). All colonies developed on Chitine agar are Actinomycetes belonging to the genus *Streptomyces*, a common component of the coastal environment (GOODFELLOW and WILLIAMS, 1983). Using epifluorescence technique 5,5 x 10^6 total cells/ml (5,8 x 10^4 autotrophic microorganisms/ml) were detected. Although a discrepance between epifluorescence and cultural counts may reflect the wellknown presence of unculturable mocroorganisms, the difference observed in this study is greater than previously reported results for the area considered (DOLZANI *et al.*, 1989). Nevertheless a longer incubation period (5-6 days) allows the development of several strains, on the higher dilution plates, belonging mainly to the genus *Rhodococcus* and to an unidentified spirillum. The SEM observation revealed a considerable amount of microorganisms of unusual shapes. Some of these have been reported previously as soil microorganisms (NIKITIN, 1973); others to the best of our knowledge, are unknown (Fig. 1 and 2). The cell wall of star shaped microorganism (Fig. 1) was studied by means of X ray microanalysis which identified the presence of silicone, a typical constituent of diatoms thecæ. In any case, the microorganism size may be consistent with a protistic nature.

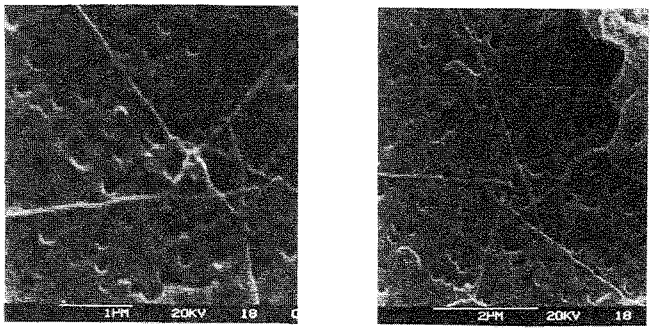


Fig.1 : Phæocystis trichocysts (SEM observation)

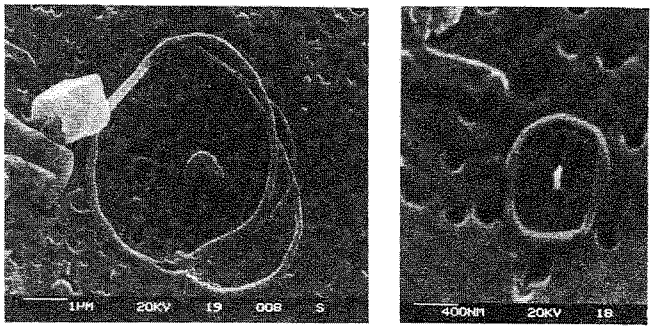


Fig.2 : Unusual shapes (SEM observation)

REFERENCES

DEL NEGRO P., MILANI L., SANZIN F., BURBA N., FONDA UMANI S., 1993 *in* Production, Environment and quality. *European Aquacolture Society*, S. 18 : 569-577.

DOLZANI L., TAMARO M., VIDMAR S., GAMBOZ C., MONTI-BRAGADIN C., 1989, *Boll. Oceano. T. Appl.*, S. : 139-146.

FUHRMAN J.A., MCCALLUM K., DAVIS A.A., 1992, *Nature*, 365 : 148-149.

GOODFELLOW M., WILLIAM S.T., 1983, *Ann. Rev. Microbiol.*, 37 : 189-216.

NIKITIN D.I., 1973, *Bull. Ecol. Res. Com.* (Stockholm), 17 : 85-92.

OKAZAKI T., OKAMI Y., 1976, *in* Actinomicetes : the boundary microorganisms. T. Arai ed. Topan Company Limitted Tokyo : 123-161.

PORTER K.G., FEIG Y., 1980, *Limol. Oceanogr.*, 25 : 943-948.

SCHNEIDER J., RHEINHEIMER G., 1991 *in* Methods in aquatic bacteriology. Austin Ed. Edinburg: 73-93.

PHYSIOLOGICAL AND GENETIC CHARACTERIZATION OF A *N*-ALKANE-DEGRADING STRAIN OF *ACINETOBACTER CALCOACETICUS* ISOLATED FROM LAGUNA VENETA

R. FANI[1], A. GRIFONI[1], L. DA ROS[2], V.U. FOSSATO[2], A. GUIDONI[3], M. PEPI[3] and F. BALDI[3]

[1] Dipart. di Biologia Animale e Genetica, Univ. di Firenze, Via Romana 17, Firenze, Italia
[2] Istituto di Biologia del Mare, C.N.R., Castello 1364/A, 30122 Venezia, Italia
[3] Dipart. di Biologia Ambientale, Univ. di Siena via Mattioli, 4, 53100 Siena, Italia

The presence of petroleum into the oceans represents one of the most important cause of the marine pollution. The major contribution of petroleum into the oceans has been attributed to deliberate releases of oil from marine operations followed by accidental spills in connection with oil transport. The role of oil degrading bacteria is known since 1950, but only later the molecular genetics of oil degradation was studied (CHAKRABARTY *et al.*, 1973). In spite of the enumeration of oil degrading bacteria carried out frequently in many parts of the world, the identification at genus, species and strains level of these bacteria is poorly investigated. The presence of oil degrading bacteria was investigated in water samples collected throughout the Laguna Veneta (GALASSI and CANZONIER, 1978) and the effect of phosphate and nitrate concentration on the kinetics of oil biodegradation in the lagoon water were also investigated.

Sixty three strains of oil degrading bacteria were isolated from three different stations of the Laguna Veneta; one of these strains, VE-C3, was isolated from station C. The *n*-alkane degrading activity of this strain was tested by gas chromatography equipped and the degradation rate of respiratory activity was measured under laboratory condition by oxygen consumption determined by Clark's electrode.

Physiological tests allowed to assign this strain to the species *Acinetobacter calcoaceticus* subsp. *haemoliticus*. In this study we also report the molecular characterization of this strain including determination of 16S rDNA sequence, plasmid profile and identification of genes homologous to *Pseudomonas oleovorans alk* genes. The 16S rDNA from strain VE-C3 was obtained via PCR by amplifyng the genomic DNA with ad hoc oligonucleotides designed on the basis of conserved prokaryotic 16S rDNA. The nucleotidic sequence obtained showed the highest degree of sequence homology with the *A. calcoaceticus* 16S rDNA, showing a correspondence in the genus assignment performed by physiological and molecular methods.

Since in *P. oleovorans* the *alk* genes that are responsable for *n*-alkane degradation are localized on OCT plasmid (GRUND *et al.*, 1975; EGGINK *et al.*, 1987), the presence of plasmid(s) was investigated by agarose gel electrophoresis of the DNA extracted. The electropherogram showed the presence of two plasmids of different dimensions, 10 and 20 kb (figure 1). To verify if the ability to degrade *n*-alkanes possessed by VE-C3 strain could be due to the presence of genes homologous to the *P. oleovorans alk* genes, a Southern blotting experiment was carried out using as probe the 4.58 PstI-PstI fragment containing *P. oleovorans alk* BFGH genes.

The targets were represented by total DNA and plasmid DNA previously digested by appropriate restriction enzymes. The hybridization signals obtained were found on chromosomal and plasmid DNA of VE-C3 strain showing the presence of genes homologous to the *P. oleovorans alk* genes with genomic and plasmidic location; this fact suggested that the organization of the *alk* genes in *A. calcoaceticus* could be different from that of *P. oleovorans*.

REFERENCES

CHAKRABARTY A.M., CHOU G. and GUNSALUS C., 1973. Genetic regulation of octane dissimilation plasmid in *Pseudomonas*. *Proc. Natl. Acad. Sci.* USA., 70 : 1137-1140.

EGGINK G., VAN LELYVELD P.H., ARNBERG A., ARFMAN N., WITTEVEEN C. and WITHOLT B., 1987. Structure of the *Pseudomonas putida alk*BAC operon. Identification of transcription and translational products. *J. Biol. Chem.*, 262 : 6400-6406.

GALASSI S. and CANZONIER W. J., 1977. Applicazione di un nuovo metodo per la determinazione dei batteri che degradano idrocarburi nel bacino meridionale della laguna veneta. *Atti Ist. Veneto Sci.*, 135 : 157-167.

GRUND A., SHAPIRO J., FENNEWALD M., BACHA P., LEAHY J., MARKBREITER K., NIEDER M., and TOEPFER M., 1975. Regulation of alkane oxidation in *Pseudomonas putida*. *J. Bacteriol.*, 139 : 546-556.

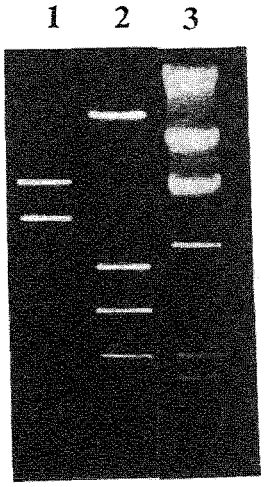


Figure 1. Plasmid profile of *A.c alcoaceticus* strain VE-C3. Lanes: 1)VE-C3 plasmid DNA; 2) VE-C3 plasmid DNA digested with EcoRI restriction enzyme; 3) molecular weight marker II, λDNA/HindIII.

LES ALGUES MARINES, SOURCE D'OSMOPROTECTEURS POUR *ESCHERICHIA COLI*

GHOUL Mostefa

Laboratoire d'écologie microbienne, Institut de biologie, Université de Sétif, 19000 Algérie

L'étude de la croissance de *E. coli* en milieu salé et de l'accumulation intracellulaire d'osmoprotecteurs en présence d'algues marines macroscopiques a été menée. Seize souches de *E. coli* ont été isolées pour ce travail, toutes isolées du milieu marin. Les algues macrobenthiques appartiennent aux Phéophycées : *Ascophyllum nodosum* et *Fucus serratus*, aux Chlorophycées : *Ulva lactuca et Enteromorpha ramulosa*, et aux Rhodophycées : *Palmaria palmata*.

L'étude de l'halotolérance bactérienne d'une population de *E. coli* est réalisée sur deux types d'extraits : aqueux et hydro-alcooliques. D'une part, chaque algue (2,5g, poids humide) est finement coupée et immergée dans 50 ml de M63, milieu minéral minimum, additionné de glucose (10 mM). L'osmolarité du milieu est augmentée par addition de NaCl aux concentrations finales suivantes : 0 - 0.5- 0,68- 0,85- 1,02- 1,20 M. Les milieux sont autoclavés à 110 °C pendant 30 mn. Après décantation, les surnageants constitueront les extraits aqueux. D'autre part, 50 g d'algue (poids humide) sont homogénéisés au mixer dans de l'éthanol 70% (v/v). Après décantation, les extraits hydro-alcooliques sont filtrés, évaporés à sec puis récupérés dans 10 ml d'eau distillée. Les extraits sont ajoutés aux solutions de M63 à la dilution finale 10^{-2}. Des témoins, sans apport d'algues et en présence de glycine bétaine (puissant osmoprotecteur), sont réalisés. En outre, la croissance bactérienne d'une souche de *E. coli* (ZB400) est étudiée en présence de thalles d'algues entières découpés en fins morceaux (2,5 g, poids humide) immergés dans du M63 / NaCl 0,85 M et en présence d'extraits hydro-alcooliques d'algues (dilution finale 10^{-2} dans du M63/ NaCl 0,85 M). Des témoins sans apport algal (M63 / NaCl 0,85 M) sont réalisés.

La mise en évidence de composés -oniums (ammoniums quaternaires et sulfoniums tertiaires auxquels appartiennent les molécules osmoprotectrices) dans des extraits hydro-alcooliques est réalisée par électrophorèse sous haute tension (40 V/cm). De telles substances sont-elles accumulées par *E. coli* soumise à une forte osmolarité du milieu (M63 / NaCl 0,85 M) ? La substance, principalement accumulée par *E. coli* à partir d'une algue donnée et déterminée par électrophorèse, est ensuite purifiée par chromatographie sur papier. L'identification de cette substance, étape finale, est réalisée par chromatographie sur couche mince (CCM) puis par spectroscopie de résonance magnétique nucléaire (RMN-^{1}H). Parallèlement, le dosage des composés -oniums, azote aminé et protéines, est effectué dans des extraits hydro-alcooliques.

La croissance des souches de *E. coli* soumises à un stress salin est largement améliorée en présence des deux types d'extraits d'algues, hydro-alcooliques et aqueux, dont les capacités osmoprotectrices sont très importantes et, dans certains cas, peuvent dépasser celles de la glycine bétaine. Les extraits favorisent la croissance bactérienne respectivement jusqu'à des teneurs en sel de 1,02 et 1,20 M. Dans les deux cas, *U. lactuca* et *P. palmata* sont les plus performantes : la croissance de plus de 30% des souches est encore constatée.

Le suivi de la croissance de *E. coli* ZB400 révèle que l'addition de thalles d'algues ou d'extraits hydro-alcooliques dans du M63 /NaCl 0,85 M accélère la multiplication bactérienne. En présence de thalles d'algues, les numérations bactériennes, en 48 heures, sont élevées : 5.108 UFC/ml (*U. lactuca* et *P. palmata*),108 UFC/ml (*E. ramulosa*). La croissance est lente avec *F. serratus* ou inhibée avec *A. nodosum*. En présence d'extraits hydro-alcooliques, la croissance est considérable : elle atteint des valeurs optimales avec *U. lactuca* et *P. palmata* (1011 UFC/ml)(phénomène de diauxie), et des valeurs moyennes avec *E. ramulosa* et *F. serratus* (109 UFC/ml). Concernant *A. nodosum*, l'inhibition n'est plus véhiculée par l'extrait (5.108 UFC/ml).

L'électrophorèse sous haute tension révèle l'extrême richesse des extraits en composés Dragendorff-positifs. Elle montre d'autre part que *E. coli* accumule ces mêmes composés à partir de thalles d'algues ou d'extraits. Deux à quatre composés Dragendorff-positifs sont accumulés à chaque fois à partir d'une algue donnée. Celui qui s'est révélé principalement accumulé, a été purifié puis identifié par CCM et RMN-^{1}H : *E. coli* accumule de la glycine bétaine à partir de *P. palmata* et *E. ramulosa*, du diméthylsulfonopropionate (DMSP) à partir de *U. lactuca*, et de la γ-butyrobétaine à partir de *A. nodosum* et *F. serratus*. Les résultats des dosages ont montré que *A. nodosum* et *F. serratus* sont plutôt riches en azote aminé et protéines, *P. palmata* en composés -oniums, *U. lactuca* en composés -oniums et azote aminé. *E. ramulosa* est pauvre en ces différents composés.

Les macroalgues marines favorisent donc la croissance de *E. coli* soumis à de fortes osmolarités du milieu. Ceci peut être attribué aux substances osmoprotectrices et probablement à leurs effets synergiques ainsi qu'à la présence d'autres substances organiques utilisables par *E. coli* comme éléments nutritifs.

Les macroalgues marines constituent, *in vitro*, une source d'osmoprotecteurs pour *E. coli*, bactérie de contamination du milieu marin. Elles favoriseraient (débris, excrétion...) ainsi la survie de *E. coli* et d'autres entérobactéries dans certains compartiments benthiques de ce milieu.

RÉFÉRENCES

BLUNDEN G., SMITH B.E., IRONS M.W., MING-HE YANG, ROCH O.G., et PATEL A.V., 1992. Betaines and their sulphonium compounds from 62 species of marine algae. *Biochemical Systematics and ecology*. 20 : 373-388.

FLATAU G.N., CLEMENT R.L., GAUTHIER M.J., et PUEL D.C., 1992. Effect of incubation of *Escherichia coli* cells with halophyte extracts on their subsequent survival in seawater. *Canadian Journal of Microbiology*. 38 : 838-842.

M

DIE-OFF RATE OF *STAPHYLOCOCCUS AUREUS* IN SEA-WATER

Nada KRSTULOVIC and Mladen SOLIC

Institute of Oceanography and Fisheries, P.O.Box 500, 58000 Split, Croatia

All strains of coagulase positive *Staphylococcus aureus* are pathogens, causing a wide range of infections. They have been found to be shed by bathers under all conditions of swimming. Being salt tolerant they may survive in the marine environment, presenting a potential health hazard to bathers on crowded beaches.

The effect of solar radiation, temperature, salinity and predation on the survival of *S. aureus* was studied in laboratory experiments using 2^k factorial designs. Survival of studied bacterial group was expressed as T_{90}, the time required for a 90% reduction in bacterial number.

The number of *S. aureus* was determined by membrane filtration using a Baird-Parker Base Agar (Biolife). The culture of *S. aureus* for survival experiments was supplied by the Institute of Public Health, Split, Republic of Croatia.

T_{90} values under light conditions ranged from 8.0 to 11.9 hours, and under dark conditions from 115.1 to 422.5 hours. Survival of *S. aureus* was statistically significantly longer than survival of all faecal indicator groups (TUDOR *et al.*, 1990). An inverse relationship existed between survival of *S. aureus* and all studied factors. The largest negative effects were the main effects of solar radiation, temperature and predation, while the largest positive effects were the interactions between solar radiation and temperature, and between solar radiation and predation (Tab.1).

The results showed that solar radiation was the dominant factor in controlling the survival of *S. aureus*. The effect of temperature was also very important but partially obscured by the effect of solar radiation. The importance of predation in elimination of *S. aureus* from marine environments was established as statistically significant under experimental conditions. Effects of predation were more expressed under dark than under light conditions, indicating an interference effect between solar radiation and predation. Thus, solar radiation was detrimental not only to survival of *S. aureus* but also to survival and/or activity of predators inhibiting the effect of predation. Under natural conditions salinity was a less important factor controlling the persistence of *S. aureus*, suggesting their high salt tolerance.

Tab.1. Results of multifactor ANOVA comparing the main and 2-factor interaction effects of solar radiation (R), temperature (T), salinity (S) and predation (P) on the survival of *S. aureus*.

SOURCE OF VARIATION	SS	df	MS	F	P
MAIN EFFECTS	1.89 E5	4	4.72 E4	26.31	<0.005
R	1.17 E5	1	1.17 E5	64.96	<0.001
T	5.30 E4	1	5.30 E4	29.53	<0.005
S	5.18 E3	1	5.18 E3	2.89	n.s.
P	1.41 E4	1	1.41 E4	7.86	<0.05
2-FACTOR INTERACTIONS	7.32 E4	6	1.22 E4	6.80	<0.05
R x T	4.84 E4	1	4.84 E4	26.94	<0.005
R x S	4.62 E3	1	4.62 E3	2.57	n.s.
T x S	2.20 E3	1	2.20 E3	1.23	n.s.
R x P	1.29 E4	1	1.29 E4	7.19	<0.05
T x P	5.03 E3	1	5.03 E3	2.80	n.s.
S x P	1.26 E2	1	1.26 E2	0.07	n.s.
RESIDUAL	8.98 E3	5	1.80 E3		

n.s. - not significant (P>0.1)

REFERENCES

TUDOR M., SOLIC M. and KRSTULOVIC N., 1990. T_{90} of total coliforms, faecal coliforms and faecal streptococci in the Kastela Bay. *Acta Adriat.* 31 : 67-74.

M

EFFECTS OF THE SEA WATER OSMOCONCENTRATION CHANGES ON OXIDATIVE PROCESSES IN ISOLATED GILL OF SHORE CRAB *CARCINUS MEDITERRANEUS* CSRN

Dijana PAVICIC and Cedomil LUCU

Institute Ruder Boskovic, Center for Marine Research, 52210 Rovinj, Croatia

The gills of marine organisms play an important physiological role in respiration, osmoregulation and volume and acid-base regulation. Although the significance of the gills in ion transport functions in the Crustacean is evidently recognized (LUCU, 1990), the relationship between their respiratory and ion-regulatory functions has been pointed out only by few studies, not very recent (ENGEL, 1975).

The rate of oxygen consumption was measured in the posterior gills isolated from the shore crabs *Carcinus mediterraneus Csrn* collected at the coastline of the Istrian peninsula (Northern Adriatic). The gills from the intermoulting adult crabs were excised and perfused (LUCU and SIEBERS, 1986) before insertion into the oxygen chamber with an identical diluted solution in which OCR (oxygen consumption rate) was measured. Measurements were performed in a closed experimental system in the perpex chamber. A radiometer PO_2 electrode (E 5046) was protruded through the cover into the chamber and the OCR was measured by digital PHM 72 radiometer analyzer (Copenhagen) with technical details described by LUCU and PAVICIC (in prep.)

The main anearobic end product in Crustacea lactate (HILL *et al.*, 1991) was affected by the sea water osmoconcentration changes. The mean concentration of lactate in the blood was not changed significantly in the crabs acclimated to the sea water in the salinity range from 11.0 to 38 x 10^{-3}.

When gills were isolated from the crabs acclimated to various diluted sea water concentrations, the OCR was salinity-dependent and considerably increased as sea water concentration decreased. Prior to respiration measurement isolated gills were perfused by 2.5 x 10^{-3} mol l^{-1} ouabain dissolved in 50 per cent DSW (diluted sea water) and incubated in the respiration chamber. OCR was depressed by ouabain by approximately 30 per cent compared to the control solution (table 1). In the gills immersed in the N-methyl glucamine solution containing 250 mmol Cl^- l^{-1}, the OCR of the isolated preparation was close to zero, but only by the sodium substitution increased steadily. The OCR in which chloride plays a minor role, is a function of the sodium concentration changes. V_{max} was reached at 465 µl O_2 h^{-1} per gram gill wet weight and K_m at the sodium concentration of 16.8 mmol l^{-1}. Moreover, in the K-free and Ca-free saline, oxygen consumption of the excised gills was also reduced, supporting the indispensable role of the potassium and calcium ions in the respiration processes (table 1).

Dilute sea water		Physiological saline			
Control	Ouabain	Control	K-free	Ca-free	Mg-free
		(µl O_2 x h^{-1} per gram gill w.w.)			
526.19±26	365.78±36	593.41±43	362.47±33	478.15±44	573±48
	P < 0.01*		P < 0.01	P < 0.01	P > 0.05

Table 1. Effect of ouabain (2 x 10^{-3} mol l^{-1}) on gill respiration measured in the isolated posterior gills from *Carcinus mediterraneus* incubated in the DSW (260 mmol Cl/l). The gill was isolated from the crabs acclimated for 2 weeks in DSW. The mean respiration rate wase measured after it reached a steady-rate level in the isolated gills immersed in the control artificial saline (in mmol/l; NaCl, 260; KCl, 5; $MgCl_2$; $CaCL_2$, 4; HEPES, 5; pH, 8) and compared with the gill respiration rates measured in K-free, Ca-free and Mg-free saline. In the K,Ca and Mg-free solution appropriate ions were substituted by isoosmotic NaCl (N = 6 for each mean ± S.E.; * signigicantly different from corresponding control group). w.w. = wet weigh.

The results suggest that a portion of the energy liberated by the gill respiration is utilized by the gill Na,K ATPase enzyme complex maintaining Na and K concentration gradients between the extracellular and intracellular compartments.

In the Ca-free saline containing 0.1 mmol/l EGTA the OCR was reduced by about 19 per cent relative to the control Ca containing saline. ATP synthesis could be controlled by the supply of energy to the electron transport chain which is in turn controlled by cytosolic free calcium levels. It is known that in michocondria Ca is coupled with H pumping providing an electrochemical gradient or proton promotion force which is used to generate synthesis of ATP from ADP and P_i.50 per cent inhibited OCR by KCN was attained at 1 µmol l^{-1}. We suggest that electron transfert chain was blocked, and consequently oxidative capacity mediated via cytochrome oxidase activity was diminished.

REFERENCES

HILL A.D., STRANG R.C.H. and TAYLOR A.C., 1991. Radioisotope studies of the energy metabolism of the shore crab *Carcinus maenas* (L.) during environmental anoxia and recovery. *J. Exp. Biol. Ecol.*, 150 : 51-62.

ENGEL D.W., FERGUSON R.L. and EGGERT L.D., 1975. Respiration rate and ATP concentrations in the excised gills of the blue crab as a function of salinity. *Comp. Biochem. Physiol.*, 52A : 669-671.

LUCU C. and SIEBERS D., 1986. Amiloride-sensitive sodium flux and potentials in perfused *Carcinus* gill preparations. *J. Exp. Biol.*, 122 : 25-35.

LUCU C., 1990. Ionic regulatory mechanisms in crustacean gill epithelia. *Comp. Biochem. Physiol.*, 97A (3) : 297-306.

HEAT STRESS RESPONSE IN *SKELETONEMA COSTATUM*

A. PENNA[1], V. SCOCCIANTI[2] AND M. MAGNANI[1]

[1] Centro Biologia Ambientale, [2] Istituto di Botanica
University of Urbino, 61029 Urbino, Italy

Skeletonema costatum (Grev.) Cleve is a cosmopolitan marine diatom. Its main distribution is in coastal waters where it occurs frequently and often as the dominant species. Because of its ubiquitous nature and its ability to reach bloom densities, *S. costatum* has been subject of many physiological and ecological investigations. In the present paper we investigated the *in vitro* responses of *S. costatum* under conditions of temperature stress. Among the several cellular responses to stress conditions in plants and animal cells there is the synthesis of heat-shock proteins (HSPs) (NAGAO *et al.*, 1986), the activation of ATP and ubiquitin dependent degradation of damaged or unfolded proteins (RECHSTEINER, 1988), and the early changes in polyamine content (GALSTON, 1989). The results here reported show that *S. costatum* is able to activate all these responses. Furthermore, due to the importance of the production of extracellular polysaccharide in the Adriatic sea and since *S. costatum* accumulates large amounts of β-1,3-D-glucan (VÅRUM and MYKLESTAD, 1984), we also investigated the variation of polysaccharide content in *S. costatum* under temperature stress conditions.

S. costatum was cultured in the f/2 medium of Guillard and Ryther at 18°C, in a day:night cycle of 12h:12h. Polysaccharide content and polyamine content were determined according to DUBOIS *et al.* (1956) and SMITH and BES (1977) respectively. Protein pattern was analyzed by SDS-PAGE, the presence of ubiquitin and ubiquitin conjugates was revealed by western blotting. Ornithine and arginine decarboxylase activities were determined by measuring the $^{14}CO_2$ evolution from L-[1-14C] ornithine and DL-[1-14C] arginine as described by TORRIGIANI *et al.*, 1987.

S. costatum cells, usually growth at 18°C, were exposed to higher temperatures for 40 min. In cells at 25°C, 30°C and 35°C respectively, total cellular and extracellular carbohydrate content was determined. No variations in total carbohydrate content were observed; however extracellular carbohydrates increased after 40 min of 35°C stress. This production is probably not due to new synthesis but to cell disruption as supported by a corresponding decrease of the intracellular carbohydrates. At 35°C in fact a drastic decrease in cell number and viability was observed.

The temperature shift from 18°C to 30°C induced the appearance of new polypeptides typical of the heat shock response. At 35°C the protein electrophoretic pattern was similar to that observed at 18°C, suggesting that the cell protein machinery is no longer active at this temperature. Western blotting experiments performed with an anti-ubiquitin antibody revealed that *S. costatum* cells contained free ubiquitin and ubiquitin conjugates. The heat stress increased the number of ubiquitin conjugate, particularly those of high molecular weight. Thus the heat stress in *S. costatum* cells is associated with the conjugation of ubiquitin to endogenous proteins.

The polyamines putrescine, spermidine and spermine were present in *S. costatum* cells. Heat shock (40 min of 30°C stress) caused a marked increase in free putrescine and spermidine and in putrescine biosynthetic enzymes activities. A possible role for these different metabolic events in the adaptive response of *S. costatum* to rapid temperature shifts has been hypothized.

REFERENCES

BONIN D.J., DROPP M.R., MAESTRINI S.Y. and BONIN M.C., 1986. Physiological features of six micro-algal to be use as indicators of seawater quality. *Cryptogamie, Algologie*, 7 : 23.

DUBOIS M., GILLES K.A., HAMILTON J.K., REBERS P.A. and SMITH F., 1956. Colorimetric method of determination of sugars and related substances. *Analyt. Chem.* 18 : 350-356.

GALSTON A.W., 1989. Polyamines and plant response to stress. *In* : Bachrach, U., Heimer, Y.M. (eds.) The Physiology of Polyamines. CRC Press, Boca Raton, Florida.

NAGAO R.T, KIMPEL J.A., VIERLING E. and KEY J.L., 1986. The heat shock response: a comparative analysis. In Miflin, B.J. (ed.) Oxford surveys of plant molecular and cell biology. Oxford Univ. Press, Oxford.

RECHSTEINER M., 1988. Ubiquitin, Plenum Press, New York.

SMITH T. A. and BEST G.R., 1977. Polyamines in barley seedlings. *Phytochemistry*, 16 : 841-843.

TORRIGIANI P., SERAFINI-FRACASSINI D. and BAGNI N., 1987. Polyamines biosynthesis and effect of dicyclohexylamine during the cell cycle of *Helianthus tuberosus tuber*. *Plant. Physiol.*, 84 : 148-152.

VÅRUM K.M. and MYKLESTAD S.,1984. Effect of light, salinity and nutrient limitation on the production of β-1,3-D-glucan and exo-D-glucanase activity in *Skeletonema costatum* (Grev.) Cleve. *J. exp. mar. Biol. Ecol.*, 83 : 13-25.

EXPÉRIMENTATION EN CAPTEUR À MEMBRANE. RÉSISTANCE AU CUIVRE D'*ESCHERICHIA COLI* DANS LES EAUX INTERSTITIELLES DE SÉDIMENTS MARINS : RÔLE DES PROTÉINES

M. RICHOU[1], C. LE POUPON[1], D. FEVRIER[1], C. MIRRE[2], J. BENAIM[1]

[1] Laboratoire de Chimie Marine des Organométalliques, Université de Toulon et du Var, 83957 La Garde, France

[2] Laboratoire de Biologie de la différenciation cellulaire L.A. CNRS n°179, case 901, 13288 Marseille cedex 9, France

Dans les eaux naturelles, les métaux Pb^{2+}, Cu^{2+}, Zn^{2+}, Cd^{2+} sous leur forme libre sont reconnus toxiques pour les systèmes biologiques (HART, 1981).

Ainsi pour les bactéries, les ions Cu^{2+} sont indispensables dans leur métabolisme mais peuvent causer des effets cellulaires toxiques si le niveau des ions libres Cu^{2+} n'est pas contrôlé. Plusieurs types de mécanismes de résistance au Cu^{2+} ont été recensés (TREVORS, 1987; SILVER et WALDERHAUG, 1992).

L'accumulation - séquestration du cuivre par des protéines membranaires externes et périplasmiques a été proposée comme mécanisme de résistance pour un certain nombre de souches bactériennes afin d'abaisser le niveau intracellulaire d'un grand flux de Cu^{2+}. Le plasmide portant l'opéron résistant au cuivre consiste en quatre gènes cop ABCD, opérant sous le contrôle d'un promoteur cuivre (MELLANO et COOKSEY, 1988).

La présence de formes bactériennes hautement résistantes à des concentrations élevées de métaux lourds est commune dans la nature au voisinage de déchets industriels. Ces souches contiennent des mégaplasmides. *Alcaligenes eutrophus* CH 34 contient le plasmide pMOL 30 (238 Kb) qui dirige la résistance aux métaux lourds Pb^{2+}, Cu^{2+}, Zn^{2+}, Cd^{2+}. L'intérêt de ces plasmides est de pouvoir se transmettre facilement d'une souche à l'autre (MERGEAY et NIES, 1985).

Nous avons montré (RICHOU *et al.*, 1992) les possibilités de survie en capteur à membrane d'*Escherichia coli*, dans les eaux interstitielles de sédiments marins d'un port contenant des taux très élevés de métaux lourds.

Le but de ce travail a été de déterminer si la forme de résistance aux métaux Cu^{2+} d'*Escherichia coli* est due essentiellement à un mécanisme d'accumulation qui lui est propre ou/et si la possibilité de transmission de plasmide de bactéries du sédiment marin d'une souche à l'autre existe, ce qui augmenterait sa résistance.

Pour cela, les bactéries *Escherichia coli* sont placées dans un capteur à membrane. Des expériences en écosystème contrôlé sont effectuées dans des sédiments marins méditerranéens chargés en métaux lourds.

La résistance au cuivre d'*Escherichia coli* est testée. Pour cette étude, nous avons effectué des cultures cellulaires d'*Escherichia coli* témoins et après expérimentation *in situ*. Ces cultures se déroulent en absence et en présence de cuivre jusqu'à 4 mM pendant 20 heures.

A partir de cellules entières, de cellules lysées et de cellules fractionnées, les protéines totales, solubles et insolubles sont identifiées par leur masse molaire par électrophorèse de type LAEMMLI et quantifiées par la méthode de BRADFORD. Le dosage du Cu^{2+} libre, complexé et/ou accumulé par les différents types de protéines est effectué par Differential Pulse Ánodic Stripping Voltammetry (D.P.A.S.V.) par la méthode des ajouts dosés. Le nombre de sites de fixation du Cu^{2+}des différents types de protéines est ainsi déterminé en µmoles d'équivalent Cu^{2+} par µg de protéines en solution.

L'ensemble de ces résultats semble prouver l'existence chez *Escherichia coli* d'un mode de résistance au Cu^{2+} par accumulation par les protéines qui lui est propre et une augmentation de cette résistance après contact avec le milieu naturel.

REFERENCES

HART B.T., 1981. Trace metal complexing capacity of natural waters : a review. *Environmental Technology letters*. 2 : 95-110.

MELLANO M.A. et COOKSEY D.A., 1988. Induction of the copper resistance operon from *Pseudomonas syringae*. *J. Bacteriol.*, 170 : 4399-4401.

MERGEAY M. et NIES D., 1985. *Alcaligenes eutrophus* CH34 Is a facultative chemolithotroph with plasmid-bound resistance to heavy metals. *J. Bacteriol.*, 162 : 328-334.

RICHOU M., MIRRE C., BENAMOU C., MOUREAU Z., BENAIM J., 1992. Expérimentation en capteur à membrane. Taux de survie d'*Escherichia coli* dans les eaux interstitielles de sédiments marins. *Rapp. Comm. int. Mer Médit.*, 33 : 201.

SILVER S. et WALDERHAUG M., 1992. Gene regulation of plasmid-and chromosome-determined inorganic ion transport in bacteria. *Microbiol. Rev.*, 56 : 125-228.

TREVORS J.T., 1987. Copper resistance in bacteria. *Microbiol. Sci.*, 4 : 29-31.

M

QUELQUES DONNÉES BIOCHIMIQUES CHEZ *MYTILUS GALLOPROVINCIALIS* LMK DU LITTORAL ROUMAIN DE LA MER NOIRE

Natalia ROSOIU

Université "Ovidius", faculté de médecine, Constantza, Romania

Les déterminations biochimiques ont été effectuées saisonnièrement, en concordance avec les méthodes antérieurement décrites (ROSOIU, 1976; ROSOIU *et al.*, 1990; STEPANOV *et al.*, 1989), sur les moules de rocher, en prenant pour chaque analyse le tissu obtenu d'environ 100 exemplaires de *Mytilus galloprovincialis* Lmk 4-5 cm de longueur. Les composants biochimiques déterminés sont exprimés en g% du tissu sec.

Chez *Mytilus galloprovincialis*, la matière organique totale, les éléments minéraux, les protéines, les lipides, les glucides présentent de grandes variations. La quantité maximale de substance organique (87,00-95,00%) est enregistrée au cours du printemps et en automne. Le taux de protéines (35,15-69,40%) présente un maximum au cours du printemps, celui des lipides (9,5-14,85%) au printemps et à la fin de l'été, et celui des glucides (5,67-43,75%) en automne lorsque le glycogène s'accumule en tant que substance énergétique de réserve. L'accumulation de 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) à la reproduction. En automne, l'organisme accumule en vue de l'hivernage.

Le spectre lipidique reflète une riche teneur en acides gras, glycérides, phospholides et sphingolides.

	En grammes, % de substance sèche	en grammes, % de lipides totaux
Lipides totaux	9,49 - 14,85	-
Acides gras :		
- totaux	7,55 - 12,75	79,02 - 85,86
- libres	1,18 - 1,76	11,85 - 12,43
Acide oléique		11,60
Acide linoléique		11,60
Acide linolénique		14,60
Glycérol	0,98 - 1,29	8,69 - 10,33
Glycérides	6,00 - 12,28	63,22 - 82,69
Phospholipides	1,52 - 2,38	16,02 - 17,00
Sphingolipides	0,13 - 0,21	1,37 - 1,42

Tableau 1

En analysant les données ci-dessous :

- indice d'iode (g I_2/100 g acides gras) = 91,2,
- poids moléculaire moyen des glycérides = 371,8,
- poids moléculaire moyen des acides gras totaux = 288,9,

on constate que chez *Mytilus galloprovincialis* Lmk, les acides gras ont un degré moyen de non-saturation. Les poids moléculaires moyens des glycérides neutres et ceux des acides gras totaux ainsi que les données présentées dans le tableau 1, montrent que *Mytilus galloprovincialis* Lmk contient des acides gras supérieurs, ayant une longue chaîne d'atomes de carbone dans leur molécule parmi lesquels prédominent les acides gras suivants : oléique, linoléique et linolénique.

RÉFÉRENCES

ROSOIU N., 1976. The dynamics of lipidic fractions from mussel, during its annual biogical cycle. St. *Cercet. Biochim.*, 19, 2 : 175-181.

ROSOIU N., PANAIT M., 1990. Recherches sur la biochimie des principales espèces de mollusques benthiques et de poissons du littoral roumain de la mer Noire. *Cercetari marine,* 23 : 137-145.

STEFANOV K., SEIZOVA K., KONAKLIEVA M., POPOV S., PETKOV G., ROSOIU N., CRASMURU M., 1989. Lipids and sterols in some molluscs collected from the Romanian Black Sea coast. FECS. Fifth International Conference on chemistry and biotechnology active natural products. Varna (Bulgaria), 2 : 273-280.

M

RELATIONSHIP BETWEEN BACTERIA AND HETEROTROPHIC NANOFLAGELLATES IN THE COASTAL ADRIATIC SEA

Mladen SOLIC and Nada KRSTULOVIC

Institute of Oceanography and Fisheries P.O.Box 500, 58000 Split, Croatia

Abundance and production of bacteria and heterotrophic nanoflagellates (HNF) were studied over a year in Kastela Bay (Adriatic Sea). Enumeration of studied organisms was made by epifluorescence microscopy using the standard AODC technique (HOBBIE *et al.*, 1977) for bacteria, and proflavine staining technique (HAAS, 1982) for HNF. Bacterial cell production was measured with the H-thymidine incorporation technique (FUHRMAN & AZAM, 1982), whereas cell production of HNF was estimated using a filtration/inoculation method (SHERR *et al.*, 1984).

Bacterial abundance ranged from 0.40 x 10^6 to 2.06 x 10^6 cells ml^{-1} showing mean value of 1.31 x 10^6 cells ml^{-1}. The values for HNF varied from 0.18 x 10^3 to 3.45 x 10^3 cells ml^{-1}, with mean of 1.59 x 10^3 cells ml^{-1}. High bacterial abundance presented from May to September was followed with marked decrease in October-November period (Fig.1A). Another bacterial peak was observed in winter (December-January). On the other hand, HNF abundance was significantly higher during the warmer part of the year (July-November) in comparison to colder winter-spring period. HNF peak reached in August could be a response to bacterial summer peak, but there is no response to bacterial winter peak. Correlation between bacterial and HNF abundance was not established across the year, probably as a result of predator-prey oscillations, and complex trophic interactions with numerous feedbacks. The ratio between bacterial and HNF abundance ranged between 148 and 5225 with mean value of 1568, or expressed as carbon biomass ratio the mean value was 4.1. Bacterial production ranged from 0.37 x 10^4 to 12.42 x 10^4 cells $ml^{-1}h^{-1}$, with mean value of 4.45 x 10^4 cells $ml^{-1}h^{-1}$. Production of HNF varied between 3.08 and 166.21 cells $ml^{-1}h^{-1}$ with mean value of 45.88 cells $ml^{-1}h^{-1}$. Expressed as carbon biomass, HNF production accounted on average 39% of bacterial production. Population doubling time ranged from 0.6 to 7.8 days (mean value was 2.1 days) and from 0.6 to 5.6 days (mean value was 2.7 days) for the bacteria and HNF, respectively. Both bacterial and HNF production were in maximum during summer (July-September) (Fig.1B). Therefore, high correlation between bacterial and HNF production was established (R^2 = 0.81; P < 0.001; n = 48) pointing at strong trophic relationship between these two groups of organisms.

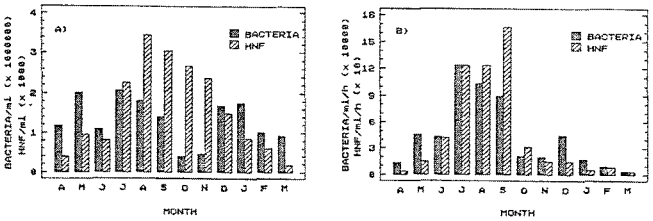


Fig.1 Seasonal oscillations of bacterial and heterotrophic nanoflagellates (HNF) abundance (A) and production (B).

REFERENCES

FUHRMAN J.A. and AZAM F., 1982.Thymidine incorporation as a measure of heterotrophic bacterioplankton production in marine surface waters : evaluation and field results. *Mar. Biol.*, 66 : 109-120.

HAAS L. W., 1982. Improved epifluorescence microscopy for observing planktonic micro-organisms. *Ann. Inst. Oceanogr.*, Paris 58 : 261-266.

HOBBIE J.E., DALEY R.J. and JASPER S., 1977. Use of Nucleopore filters for counting bacteria by fluorescence microscopy. *Appl. Environ. Micribiol.*, 33 : 1225-1228.

SHERR B.F., SHERR E.B. and NEWELL S.Y., 1984. Abundance and productivity of heterotrophic nanoplankton in Georgia coastal waters. *J. Plankt. Res.*, 6 : 195-202.

THE MUG TEST FOR A RAPID EVALUATION OF *ESCHERICHIA COLI* IN SEAWATERS

ZACCONE R., MONTICELLI L., CARUSO G.

Istituto Sperimentale Talassografico CNR, Sp. S. Raineri, 86-98122 Messina, Italia

Monitoring seawater pollution requires prompt and reliable answers, enabling researchers to carry out prompt and adequate measures. When compared with the enumeration methods of fecal and total coliforms, researches focusing on the use of *E. coli* as indicator cells result in a more accurate indicator-pathogen ratio (FREIER and HARTMAN, 1987; ZACCONE *et al.*, in press). Some media containing fluorogenic substrates have recently been used for the direct identification of *E. coli* as well as pathogenic bacteria, *Shigella, Salmonella.*

The 4-methylumbelliferyl-β-D glucuronide (MUG) is a fluorogenic substrate, specific for *E. coli* : it possesses the enzyme β glucuronidase, which is involved in the lactose metabolism. For a rapid determination of *E. coli*, we have studied the accuracy and sensitivity of a medium containing MUG substrate and compared it to the m-FC medium. Seawater samples have been collected from several coastal areas of Sicily, filtered through 0,45µm Nuclepore membranes, and placed on the following media : m-FC Broth (Difco) + 1,2% Agar (Difco) without rosolic acid, incubated for 24 hours at 44.5°C (STANDARD METHODS, 1992); EDC Agar MUG (Biolife), incubated for 18 hours at 37°C and 44.5°C. The suggested method provided for a pre-incubation on Tryptic Soy Agar at 37°C for 4 hours. We avoided this step in order to study the possible application of such method during coastal survey in a ship laboratory. The presumptive target colonies classified as presumed *E. coli* were identified by the API 20E system. The data have been processed to obtain accuracy coefficient (A.C. = n. of confirmed *E. coli* target colonies/presumptive target colonies) and selectivity coefficient (S.C. = presumptive target colonies/ presumptive target colonies + presumptive non target colonies) (Fig.1) and an analysis of media performance has been carried out (Tab. 2) (SANTIAGO-MERCADO and HAZEN, 1987; PAGEL *et al.*, 1982).

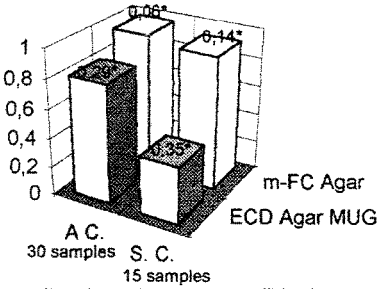


Fig 1: Comparison of recovery efficiencies.
* Standard deviation

	ECD Agar n	%	m-FC Agar n	%
E. coli	166	84,69	69	94,52
K. rhinoscleromatis	5	2,55		
K. oxytoca	1	0,51		
C. freundii	1	0,51	1	1,36
P. vulgaris	1	0,51		
Vibrio spp.	7	3,57		
Pseudomonas spp.	3	1,53	2	2,73
Gram -, ox -, non identified bacteria	2	1,02		
Yellow pigment	10	5,10	1	1,36
Total	196	99,99	73	99,97

Tab.1. Identification of presumptive target colonies grown on ECD Agar MUG and m-FC Agar

The m-FC Agar medium presents a higher A.C. when compared with the ECD Agar MUG; this is due to the higher percentage of confirmed *E. coli* (lower number of false-positive colonies) in the presumptive target colonies isolated from both media (Fig.1, Tab.1). The growth of non target background organisms was higher for ECD Agar MUG than m-FC; this is mainly due to the different composition of media as well as to the different qualitative composition of sample microflora. This is also shown by C.S. values (Fig.1). The m-FC Agar presents a higher selectivity towards the other bacterial species.

Tab. 2 shows the effect of both incubation temperatures on the samples inoculated on ECD Agar MUG. When a temperature of 44.5°C was utilized, the bacterial counts decreased (only 7% of samples has higher recovery on ECD Agar MUG). Incubation temperature of 37°C allows the recovery of a higher amount of presumptive target colonies (58% of samples). The possibility of *E. coli* direct enumeration at 37°C may support the recovery of stressed cells, avoiding the introduction of a resuscitation procedure. However, the higher performance of ECD Agar is inconsistent with a lower accuracy and selectivity. The existence of a direct proportionality between two media was proved by calculating the correlation coefficient (Tab.2).

For preliminary environmental surveys of *E. coli* the use of ECD Agar incubated at 37°C may be suggested.

Media (temperature of incubation)	n	%	Performance
ECD Agar(44,5°C)/m-FC Agar (44,5°C)	21	75	mFC Agar(100)>ECD Agar(37,02)* (4,32)**
	2	7	ECD Agar(100)>mFC Agar(40,00)* (4,47)**
	5	18	m-FC Agar = ECD Agar
r=0,97 P<0,01			
ECD Agar(37°C)/ m-FC Agar (44,5°C)	11	58	ECD Agar(100)>mFC Agar(48,15)* (4,42)**
	3	16	mFC Agar(100)>ECD Agar(66,76)* (0,07)**
	5	26	m-FC Agar = ECD Agar
r=0,91 P<0,01			

Tab. 2 : Growth of presumptive target organisms (performance of media)
* percentage mean ** standard error

REFERENCES

FREIER T.A. and HARTMAN P.A.,1987. Improved membrane filtration media for enumeration of total coliforms and *Escherichia coli* from sewage and surface waters. *Appl. Environ. Microbiol.*, 53 : 1246-1250.

PAGEL J.E., QURESHI A.A., YOUNG D.M., VLASSOFF T.L., 1982. Comparison of four membrane filter methods for fecal coliform enumeration. *Appl. Environ. Microbiol.*, 43 : 787-793.

SANTIAGO-MERCADO J. and HAZEN T.C., 1987. Comparison of four membrane filter methods for fecal coliforms enumeration in tropical waters. *Appl. Environ. Microbiol.*, 53 : 2922-2928.

STANDARD METHODS FOR EXAMINATION OF WATER AND WASTEWATER, 1992. 18th. edition, APHA Washington.

ZACCONE R., CRISAFI E., CARUSO G., in press. Evaluation of fecal pollution in coastal waters by immunofluorescence. *Mar. Microb. Food Webs.*

M

O

COMITÉ
OCÉANOGRAPHIE PHYSIQUE

Président : Claude MILLOT
Vice-Présidents : Alexandre LASCARATOS,
Antonio MICHELATO

SOME FEATURES OF WATER CIRCULATION AND HYDROLOGICAL STRUCTURE IN THE NORTH-EASTERN PART OF THE LEVANTINE SEA

I. ABOUKORA[1], C. BOURAS[1], V.G. KRIVOSHEYA[2], L.V. MOSKALENKO[2], I.M. OVCHINNIKOV[2], V.G. YAKUBENKO[2]

[1] The Scientific Centre of the Syrian Arabian Republic, Damascus, Syrie
[2] South. Branch of P. P. Shirshov, Inst. of Oceano. of the Ac. of Science, Gelendzhik, Russia

Hydrophysical observations performed by r/v "Vityaz" in the Levantine Sea were assumed as basin of studies. They were carried out in the region between the island of Cyprus and Syrian coast in winter 1992 and autumn 1993. During the 24th expedition in the course of two hydrophysical surveys (February 15-22 and March 5-8, 1992) 105 stations were made. During the 27th expedition the similar surveys were performed in October 8-13 and 24-28 and comprised 107 stations. The measurements of z, T and S were carried out with Neil Brown probe to the depth of 800-1000 m with the distance between the stations about 10 miles. First of all, it is necessary to note that in severe winter 1992 the whole water column down to the main pycnocline (to the upper boundary of deep waters) was covered by convection. That is why with the increasing of winter circulation the whole homogenous water was covered by the complex but mostly unidirectional transport from the South to North. In autumn 1993 within the region of measurement, the well-pronounced multilayer water structure was yet preserved. Therefore in the most upper layer over the seasonal thermocline and under it the water circulation had sometimes large differences including opposite directions of currents.

In recent years, a great attention is paid to theoretic and experimental studies of the meandering processes of the Main current in the Mediterranean Sea and eddy making at its lateral boundaries. As is seen from the comparison of dynamic maps estimated relative to 500 dbar depth for several surveys, both in winter (the dynamic map is not given in the summary) and in autumn (Fig. 1) the water circulation in the region under studies is characterised by the strong meandering of the Main Stream, complex eddy structure of currents, their considerable synoptic and seasonal variation. It differs essentially from a classic concept of the main South to North water transport within the polygon. According to the data of four surveys the cyclonic system of circulation with two or several smaller centres is observed to the left of the Main current near the eastern coast of Cyprus. The cyclonic gyre developing to the east of Cyprus is the most stable. The co-ordinates of its centre are 34°45' N and 34°30'-34°45' E. The forming of large anticyclonic meanders with closed anticyclonic eddies inside was observed to the right of the Main current. In winter 1992, the anticyclonic circulation was formed between the eastern coasts of the Levantine Sea and 35° E. According to the data of the first winter survey, the anticyclonic eddy was located to the south-west of Latakia and had its centre co-ordinates 35°15' N and 35°30' E. According to the data of the second survey, the development of cyclonic system in the north-western part of the polygon and of anticyclonic circulation to 35° E in its southeastern part was noted. The anticyclonic circulation was outlined at the northern boundary of the polygon (35°50' N). In such a way, in winter 1992 the general South to North water transport through the most part of the polygon was well traced not only at the surface but also at the intermediate depths. The water circulation at the surface in autumn 1993 (Fig. 1) was characterised by the intensive development of large anticyclonic system in the North and the weak development of anticyclonic circulation near the eastern coast (as compared to winter). That is why the water transport to the North in the north-western part of the polygon turned out to be shifted to the West (to Cyprus), but in the South-East it was traced almost along Syrian coast (with the exception of small local cyclonic eddies near the shore). Dynamic maps for the deeper layers (250/500 dbar; Fig. 1b) are essentially different from the water circulation at the surface. The intensive anticyclonic eddy in the northern part of the polygon weakens with depth and is shifting to the North. In the central part of the polygon, the intensive anticyclone is found with its centre co-ordinates 35°15' N and 35°15' E (Fig. 1b) which covers almost the whole polygon to 34°40' N. This eddy is absent at the surface and is slightly traced only at the depth of 50 m. The maximal development of the eddy was observed between 100 and 250 m where its diameter reached 30 miles. This large anticyclonic eddy which is very weak in the surface layers, has an anomalous vertical hydrological water structure in the form of a lens. In the upper layers, including the layer of seasonal thermocline, the rising of isolines is observed, but their sharp lowering is observed below (to 1000 m). The most interesting are the peculiarities of intermediate water structure of the eddy. They are characterised by the inversions of hydrological properties (some intermediate maxima of temperature and salinity), weak baroclinic stability and convection due to salinity in thin layers.

The near-shore surface waters with anomaly high salinity (39.50-39.78‰) and high temperature (26-27°C) which were observed in autumn, are of great interest. These waters formed in the local climatic conditions, may be isolated as a separate surface water mass. The high temperature of the near-shore waters in autumn provides for their baroclinic stability. But it may be supposed that these waters in the process of advective transport and in proper conditions of cooling may commence formation of the new Levantine intermediate waters. The discovery of the large anticyclonic meanders of the Main current (with the local intensive eddies inside) spreading from the shore to the open sea, allow to extend the concept of the water exchange between the near-shore and deep waters which is of a great importance for the ecology of the Mediterranean Sea.

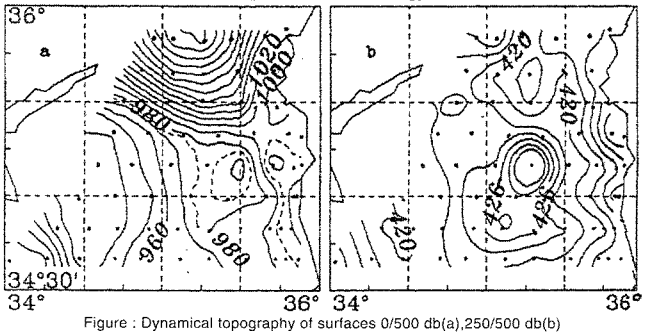


Figure : Dynamical topography of surfaces 0/500 db(a),250/500 db(b)

REFERENCES

L.V. MOSKALENKO, I.M. OVCHINNIKOV, 1991. *Oceanology*, 31, 6 : 907-915.

E. OZSOY, A. HECHT and U. UNLUATA, 1989. *Prog. Oceanog.*, Vol.22 : 125-170.

E. OZSOY, A. HECHT, U. UNLUATA *et al.*, 1991. *Dynamics of Atmospheres and Oceans*, 15 : 421-456.

YU.I. POPOV, I.M. OVCHINNIKOV, I.F. GERTMAN, 1994. VINITI, N 340-B94, 78 pp. (in Russian).

The 24th and 27th expeditions of r/v "Vityaz" were performed by joint efforts and in accordance with the agreement of mutual scientific research collaboration between the Institute of Oceanology of the Russian Academy of Sciences and the Scientific Centre of Syrian Arabian Republic.

THE NORTHERN CURRENT DYNAMICS IN THE WESTERN MEDITERRANEAN SEA

Corinne ALBEROLA[1], Claude MILLOT[1] and Jordi FONT[2]

[1] Antenne du Centre d'Océanologie de Marseille, CNRS BP 330, 83507 La Seyne/mer, France
[2] Institut de Ciéncies del Mar, CSICP. Joan de Borbu, 08039 Barcelona, Spain

In the western Mediterranean Sea, the Northern Current is a major component of the circulation, formed by the junction, in the Ligurian Sea, of the currents flowing northward along each side of Corsica. It flows all year long as an entity along the continental slope as far as the Catalan Sea, surrounding the central zone where convective phenomena occur in winter. The seasonal and mesoscale variabilities of the Northern Current have been analysed from a fortnightly hydrological survey carried out off Nice as far as ~55 km, from October 1990 to July 1991, and from ~30 current time series collected as deep as 2000 m, on 4 moorings set perpendicularly to the coast within a ~30 km coastal band, from December 1990 to May 1991, in the framework of the PRIMO-0 experiment (ALBEROLA, 1994; ALBEROLA *et al.*, 1994).

The hydrological characteristics of the different water masses have mainly evidenced some seasonal variations, concerning mainly the seaward spreading of LIW from the beginning of the formation of WMDW, the transformation of MAW into WIW in the deep winter, as well as the advection of less modified MAW. From a dynamic point of view, the seasonal variability is mainly depicted as a well-defined episode of narrowing, deepening and shoreward shift, from late January to mid-March, of a generally wide and shallow Northern Current. Currents have clearly appeared to be similar and highly correlated in an upper layer, the thickness of which is at least a hundred metres (between ~60 and 150 m), whatever the location of the points and the season are.

The flux of the Northern Current has ranged within 1-1.6 Sv, in agreement with the published values (e.g., BETHOUX *et al.*, 1982), and its temporal evolution has emphasized somewhat a rather long winter season (December-March) when relatively high values (>1.2 Sv) are maintained; the flux is maximum in December and slowly decreases till July at least. The maximum probably corresponds to the one reported by BETHOUX *et al.* (1982) and might be due to the maximum of the Eastern Corsican Current as hypothesized by ASTRALDI and GASPARINI (1992). The still-large values observed in winter might be due to the maximum of the Western Corsican Current expected to occur later on (ASTRALDI and GASPARINI, 1992), while the decrease from spring is coherent with the expected forcing phenomena and with the characteristics described by SAMMARI *et al.* (1994) who account for no marked variations from spring to early autumn.

A description of a complete annual cycle has been possible by using other observations (TAUPIER-LETAGE and MILLOT, 1986; SAMMARI *et al.*, 1994) with which ours are clearly coherent. Thus, the mesoscale activity increases from autumn to the deep winter and then displays a continuous decrease till summer at least; it has been clearly observed to propagate to the open sea in the deep winter. Mesoscale events have appeared to have a vertical extent of some few hundred metres, displaying quasi no rotation of the fluctuations with depth. So, such events should have a relatively simple vertical structure, corresponding mainly to the first baroclinic mode with its zero-crossing at 400-500 m. Currents are relatively well represented by the barotropic and first baroclinic modes, the baroclinic one being predominant and more energetic, especially in winter. However, consequently to the variations of the vein in width and depth, our most seaward mooring (~30 km) is either out or more or less in it; the dynamic regime is thus generally more complex there, except in the deep winter when the observed mesoscale events become the barotropic ones of the central zone governed by vigorous convection.

The fluctuations have generally time scales shorter in winter than in spring. Due to dramatic wintery transformations, the Northern Current is mainly altered by instability processes, leading to features looking like meanders. Indeed, it is very spectacular to note that its major fluctuations are quasi transverse within its core itself and that the anticlockwise energy increases while the clockwise energy vanishes when progressing seaward accross it. These meanders, steep and large, occur at 10-20 days and involve much more energy in winter than in spring when they have slightly shorter periods (~10 days). As previously observed (SAMMARI *et al.*, 1994), shorter fluctuations at 3-6 days are also associated with a meandering current and are expected to be intensified from spring-summer to the deep winter. The amplitudes of these meanders might be smaller than those of meanders at 10-20 days. In spring, while the flow is more stable, the predominant fluctuations look like pulses expected to have an horizontal extent of a few tens of kilometres. A fundamental observation for coastal oceanographic problems is that the circulation is actually unforeseeable in a very coastal zone (of ~10 km), dominated by turbulences. The main mesoscale phenomena, in this zone, have periods slightly shorter than well within the current.

The major seasonal and mesoscale features of the Northern Current (high flux values maintained during a relatively long winter season, narrowness and shoreward shift of the current leading the central zone to extend to the most seaward mooring) lead us to consider that the winter dense water formation should be one of the major forcings of the circulation in the northern part of the western Mediterranean Sea.

REFERENCES

ALBEROLA C., 1994. Contribution à l'étude des variabilités saisonnière et à méso-échelle de la circulation générale dans le nord de la Méditerranée occidentale. Thèse de Doctorat de l'Université Aix-Marseille II, 183 p.

ALBEROLA C., C. MILLOT and J. FONT, 1994. On the seasonal and mesoscale variabilities of the Northern Current during the PRIMO-0 experiment in the western Mediterranean Sea. Submitted to *Oceanol. Acta*, for the PRIMO special issue..

ASTRALDI M. and G.P. GASPARINI, 1992. Seasonal characteristics of the circulation in the western Mediterranean basin and their relationships with the atmospheric-climatic conditions. *J. Geophys. Res.*, 97, C6, 9531-9540.

BETHOUX J.P., L. PRIEUR and F. NYFFELER, 1982. The water circulation in the north-western Mediterranean Sea, its relation with wind and atmospheric pressure. *In* : Hydrodynamics of semi-enclosed seas, J.C.J. Nihoul ed., 129-142.

SAMMARI C., C. MILLOT and L. PRIEUR, 1994. Some aspects of the seasonal and mesoscale variabilities of the Northern Current inferred from the PROLIG-2 and PROS-6 experiments. Accepted in *Deep Sea Res.*

TAUPIER-LETAGE I. and C. MILLOT, 1986. General hydrodynamical features in the Ligurian Sea inferred from the DYOME experiment. *Oceanol. Acta*, 9, 119-131.

O

SIMULATED LAGRANGIAN MOTION IN THE TYRRHENIAN SEA

V. ARTALE[1], G. BUFFONI[2], P. FALCO[3], A. GRIFFA[4], E. ZAMBIANCHI[3,4]

[1] ENEA, Centro Ricerche Ambiente Marino, S. Teresa, La Spezia, Italia
[2] ENEA, Centro Ricerche Energia Casaccia, Roma, Italia
[3] Istituto di Meteorologia e Oceanografia, Istituto Universitario Navale, Napoli, Italia
[4] Rosenstiel School of Marine and Atmospheric Science, University of Miami, Florida, USA

We present the results of a set of numerical experiments aimed at simulating typical seasonal patterns of Lagrangian motion in the Tyrrhenian Sea. A sub-basin of the Western Mediterranean, the Tyrrhenian Sea, is enclosed by very densely populated regions. The knowledge of its Lagrangian circulation is, therefore, valuable for its possible ecological significance. The main exchanges between the Tyrrhenian and the surrounding basins occur in the North through the relatively narrow and shallow Corsica Channel and in the South through the wide opening between Sardinia and Sicily, which is dominated by recirculations of incoming and outgoing flow. Rather than by a net and stable stream flux, the circulation of the basin is dominated by a system of sub-basin scale gyres, characterized by typical length scales of the order of 150-200 km; the baroclinic Rossby radius of deformation in this area is 10-12 km. Its dynamics, and in particular the dynamics of the cyclonic gyre just East of Bonifacio Straits, have been the focus of the TEMPO experiment carried out in 1989, collecting a wide range of *in situ* and remotely measured meteorological and oceanographical parameters (see TEMPO Group, 1991).

Significant seasonal variability of this gyre circulation pattern has been shown by the results of several hydrographic surveys. In order to shed some light on the fraction of the Tyrrhenian dynamics induced by wind forcing, the surface circulation of the basin recently has been investigated by means of a simple barotropic model (ARTALE *et al.*, 1994). The model solves the barotropic equation for the vorticity conservation in the Stommel form (i.e. where dissipation is represented by a bottom friction term).

The circulation is forced by wind stress in the interior of the basin and by water mass exchange between the Tyrrhenian Sea and adjacent basins north and south of it. The four typical cases considered, one for each season of the year, are characterized by climatological mean wind stress patterns and water mass in-/outflows at the boundaries. Correspondingly, four steady-state streamfunction fields are obtained, displaying strong seasonal variations, in which three main gyres can be discerned. In the seasonal steady-state output velocity fields, simulated Lagrangian surface drifters are deployed. The Lagrangian velocity field is the combination of two factors: the mean flow, which is represented by the model output velocity field; and the turbulent part of the velocity, determined by a random flight model, which assumes it to behave as a Markovian process in time. The parameters characterizing the turbulent part of the motion are drawn from drifter data gathered in the framework of the TEMPO experiment (RUPOLO *et al.*, 1994), using techniques of parametrical estimation introduced very recently (GRIFFA *et al.*, 1994).

The resulting simulated seasonal Lagrangian patterns are presented and discussed, as well as compared with available Lagrangian data for the area.

REFERENCES

ARTALE V., ASTRALDI M., BUFFONI G., GASPARINI G.P., 1994. Seasonal Variability of the Gyre-Scale Circulation in the Northern Tyrrhenian Sea. *J. Geophys. Res.*, 99, C7 : 14127-14137.

GRIFFA A., OWENS K., PITERBARG L., ROZOVSKY B., 1994. Estimates of Turbulence Parameters from Lagrangian Data Using a Stochastic Particle Model. *J. Marine Res.*, in press.

RUPOLO V., ARTALE V., GASPARINI G.P., PROVENZALE A., 1994. A Study of Lagrangian Diffusion in the Tyrrhenian Sea. *J. Marine Res.*, submitted for publication.

TEMPO Group, 1991. Tyrrhenian Eddy Multi-Platform Observations 1989 Experiment: Inventory of the Measurements and Preliminary Results. IFA-CNR Tech. Rep., 1, pp. 69.

INVASION OF POMO PITS (MIDDLE ADRIATIC SEA) BY A COLD WATER MASS DURING SPRING 1993

A. ARTEGIANI[1], A. DE ALTERIS[1], E. PASCHINI[1], F. RAICICH[2], A. RUSSO[2]

[1] Istituto di Ricerche sulla Pesca Marittima (I.R.PE.M.), CNR, Ancona, Italia
[2] Istituto Talassografico di Trieste (I.T.T.), CNR, Trieste, Italia

In the framework of the C.N.R. project "Study of the dynamical process and circulation of the Italian Seas" (PASCHINI *et al.*, 1993), two cruises were carried out in the Middle Adriatic Sea (fig. 1) from 10 May to 7 June 1993 (Spring period). In the first cruise, an area of 42 x 36 nautical miles were covered in about 2.5 days, with 149 stations every 2 miles, alternatively with 77 CTD casts and 74 XBT launches, distributed on 7 transects. In the second cruise, in about 3 days the same area of the first cruise with one more transect to the South was covered with 87 CTD casts and 99 XBT launches.

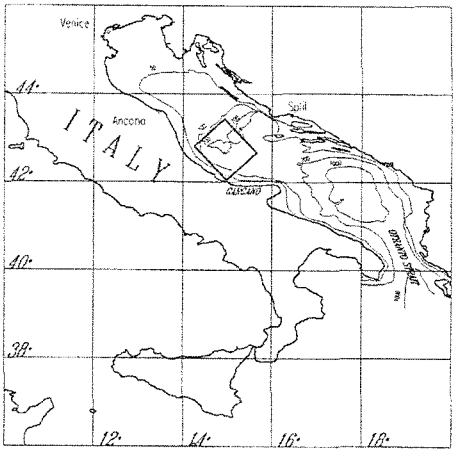


Fig. 1. Area of investigation.

A Sea Bird SBE 9/11 CTD (Conductivity, Temperature and Depth) coupled with twelve bottles GO Rosette sampler were used. The CTD was outfitted with additional sensors measuring oxygen, fluorescence and height above the bottom. In every CTD stations samples were taken at different depths for the oxygen content determination with the Winkler method; every two CTD stations water samples were taken at different depths also for the nutrients (nitrite, nitrate, phosphate and silicate) determination. In this communication only the data collected with the CTD casts are examined.

An evident evolution was registered in almost all the parameters going from the first to second cruise. The surface layer is warmer and much more less saline in the second cruise with a more pronounced thermocline; at the contrary the bottom layer of the Pomo Pit is colder than in the first survey.

In the second cruise, at around 50 m depth, is present a well pronounced salinity maximum (S > 38.6 PSU) characteristic of the MLIW (Modified Intermediate Levantine Water) (ARTEGIANI *et al.*,1994). The average fluorescence maximum depth is about the same (60 m) during the two surveys, but the maximum values, in the second cruise, is about the double than in the first one.

The dense and cold North Adriatic bottom water, still evident along Italian continental shelf in the first cruise, occupied, during the second cruise, the Pomo depression from the South side, following the isobath of about 150 m with a cyclonic path. This is particularly evident from figures 2a and 2b showing the bottom (only 2-4 meters from the sea bottom) temperature distribution during the two cruises.

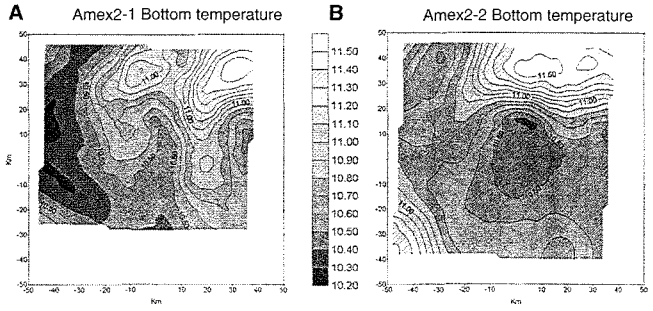


Fig. 2 - Bottom distribution of the temperature during the first cruise (A) and the second cruise (B).

REFERENCES

ARTEGIANI A., D. BREGANT, E. PASCHINI, N. PINARDI, F. RAICICH and A. RUSSO, 1994. The Adriatic Sea General Circulation Part I: air-sea interactions and water mass structure, submitted to *Journal of Physical Oceanography*.

PASCHINI E., ARTEGIANI A. and PINARDI N., 1993. The mesoscale eddy field of the Middle Adriatic Sea during fall 1988. *Deep Sea Research*, I, Vol. 40, No 7, pp. 1365-1377.

THE HYDROGRAPHIC CHARACTERISTICS OF THE WATER MASSES IN THE SICILY STRAIT AND THE SURROUNDING REGIONS

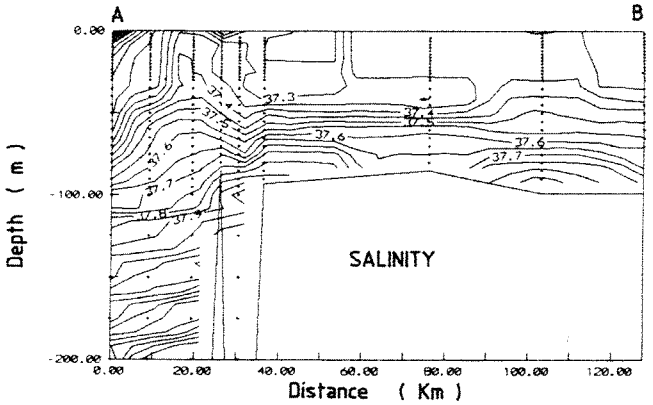
M. ASTRALDI[1], M. BORGHINI[1], G.P. GASPARINI[1], P. PICCO[2]
S. SPARNOCCHIA[1]

[1] CNR, Stazione Oceanografica, Pozzuolo di Lerici, Italia
[2] ENEA, Centro Ricerche Ambiente Marino, Pozzuolo di Lerici, Italia

The knowledge of the oceanographic conditions of the central region of the Mediterranean Sea extending between Sicily, Sardinia and the northern African coast is crucial for the comprehension of the whole basin dynamics. This region is surrounded by the three of the major straits and passages within the Mediterranean, all of them exerting a strong control on the water and particle fluxes from one basin to the other. An oceanographic investigation of this area based on periodic hydrographic stations and long-term current meters measurements along all the strait sections, was initiated in the frame of a cooperative effort among French, Spanish and Italian teams working under the sponsorship of IOC and CIESM and with the financial support of the EC (EUROMODEL and GEODYME Projects). In this frame, the hydrographic properties of the Sicily Strait and the surrounding regions were investigated during two oceanographic campaigns carried out in November 1993 and May 1994 by the Stazione Oceanografica of CNR. In this paper we present the results obtained in the two campaigns, that are to be considered preliminary to our future activity in this region.

The Sicily Strait is a two-sills, wide and relatively shallow strait, characterized by a very complicated bottom bathymetry. In agreement with the previous measurements (for all, GRANCINI *et al.*, 1972), in the Sicily Strait we are in the presence of a two-layer system divided by a transition layer. At the surface we find the Modified Atlantic Water (MAW) characterized by low salinity values and deepening as far as about 100 m of depth. All the previous measurements (for all, GRANCINI *et al.*, 1972) indicate that the flow of MAW mostly takes place close to the Tunisian coast. Being prevented to work in this area, we found a salinity minimum close to the Sicilian coast, and a wide region of mixing in the central channel (Figure). We then believe that, due to the presence of the Skerki Bank upstream of the strait, two separate veins of MAW reach the Sicily Strait, each bordering the two sides of it. In both periods, a portion of the MAW was seen to flow into the Tyrrhenian Sea, very close to the western Sicilian coast.

Below about 200 m of depth as far as the bottom, there is the Levantine Intermediate Water (LIW) characterized by high salinity values and flowing westward. At the strait section, the flux of LIW is splitted by the presence of a steep ridge, and most of it flows within the narrow valley (the eastern sill) between the ridge and the Sicilian shelf. In spite of the higher salinity values found on the other side of the ridge, this secondary vein does not seem to play an active role in the following path of the LIW. This can be observed in the hydrographic sections adjacent to the strait, just showing that, once in the western Mediterranean, LIW is conveyed as a unique vein directly toward the Tyrrhenian Sea, where it enters as a strong jet at the bottom of the Sicilian slope. The outflow of this water, with substantially modified characteristics, can be recognized in the central part of the Sicily-Sardinia passage.



The distribution of the MAW in the Sicily Strait during November 1993. A and B indicate the Tunisia and Sicily sides, respectively.

REFERENCES

GRANCINI G., A. LAVENIA and F. MOSETTI. 1972. A contribution to the hydrology of the Strait of Sicily. From "Occanography of the Strait of Sicily", Saclantcen Conference Proceedings, N. 7: 68-81.

CONTINUOUS SURVEY OF UPWELLING IN THE STRAITS OF MESSINA

F. AZZARO, F. DECEMBRINI and E. CRISAFI

Istituto Sperimentale Talassografico C.N.R., Spianata S. Raineri, 86, Messina, Italy

The presence of deep waters at the surface in the Straits of Messina was detected by VERCELLI and PICOTTI (1926), who considered this phenomenon generated by internal waves. The upwelled waters were found only near the "Sill" (located between Ganzirri and P. Pezzo) which separates the Tyrrhenian basin from the Ionian one. The upwelling occurs intermittently by oscillation of tidal levels between the two seas. In the last ten years, many hydrological studies were performed in this area using traditional methodology (CORTESE and DE DOMINICO, 1990).

During 1992 both continuous surface survey of "traciers parameters" (such as temperature, salinity and nitrate) and survey at hydrological stations were carryed out by researchers of Talassografico Istituto CNR of Messina (CESCON *et al.*, 1993). Full synoptic environmental scenary characterized by high variability in the space-time distribution of chemical and physical parameters was obtained using latter survey strategy (N/O Urania, December 1993).

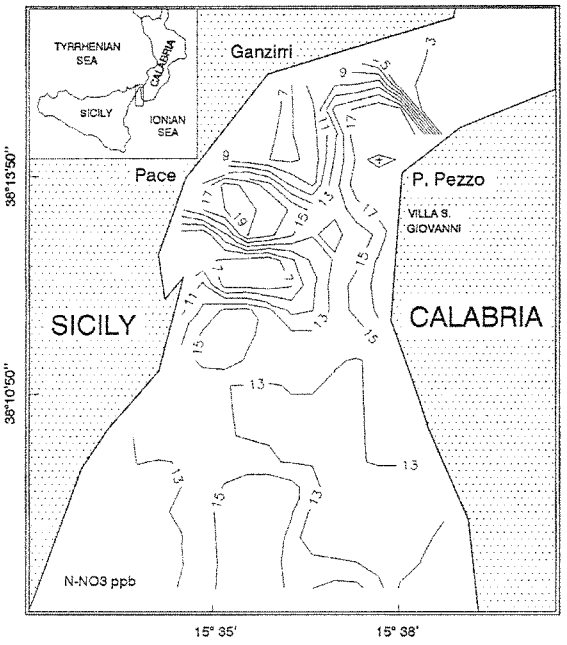
Both techniques of continuous survey of suitable traciers from sailing vessel (following the tidal wave) and 24-hour survey (every hour sampling) at three significant stations were used to investigate upwelling processes. Each continuous survey was made in about three hours around the peaks of maximum and minimum tidal level, in order to seize the quasi-stationary situations following the dynamic phases of flooding and ebbing tide respectively.

Data on surface distribution of tracier parameters evidenced a high positive correlation between nitrate and salinity in upwelled waters. The temperature values of the latter were less than 17°C whereas in the North side of the straits they exceeded 18°C. The figure shows the nitrate surface distribution after the diurnal high tide. The maximum nitrate concentration was detected alongshore both of Sicily (19.0 ppb, Pace) and Calabria (21.2 ppb, P. Pezzo). During the subsequent phase of low tide the upwelling areas are localizated only along the Calabrian coast and southwards (villa S. Giovanni, see figure). However, in all tide stages the minimum nitrate concentration was found in the northern zone of the system. Salinity ranged between 38.15 psu (in the southern zone) and 38.00 psu (in the northern zone) whereas it reached higher values (38.26 psu) in upwelled waters.

Finally, during the high tide, the upwelling is present near the Sill, mainly along the Calabrian and Sicilian coasts. During the reversed phase, the upwelled waters were located between the middle part of the Straits and the nearby Calabrian coast.

The vertical profiles at the hydrological stations, selected by the continuous survey, showed strong upwelling at the Pace station, with 12 hours frequency after low tide phase. This condition was supported by temperature mean values of 16,5°C detected at the bottom of the water column which were lower (15°C) during the upwelling phase. On the other hand at P. Pezzo station upwelling occured mainly after the high tide but even after the reversed tide, in fact in the latter phase lower temperatures were measured already at 30 m depth. The average temperature was close to 16°C at the bottom of water column (50 m) whereas these values decreased to 14°C during the upwelling stage. The Sill station monitored throughout 48 hours (at 6 h intervals during stationary current) showed upwelling phenomena only in the first 12 hours; later, the event decreased later. This phenomenon was due to reduction of tidal levels during the change of spring to neap tide.

In conclusion, the results obtained confirm the peculiar hydrodynamic features of the Straits of Messina even out of the Mediterranean sea. Further deterministic study will be based on a long term monitoring of individuated processes.



Surface distribution of nitrate (12-2-94, high tide)

REFERENCES

CESCON B., AZZARO F., CREAZZO S., DECEMBRINI F. and MAGAZZÙ G., 1993. Processing affecting upwelling and primary productivity of the Strait of Messina. (submitted to *Boll. Geof. Teor. e Appl.*).

CORTESE G. and DE DOMINICO E., 1990. Same consideration on the Levantine Intermediate Water distribution in the strait of Messina. *Boll. Geof. Teor. e Appl.*, 8 (3) : 197-207.

VERCELLI F. and PICOTTI M., 1926. Crociere per lo studio dei fenomeni dellostretto di Messina. Comm. Inter. del Mediterraneo, Venezia, 1-161.

O

PRELIMINARY RESULTS ABOUT THE STABILITY OF AN INTERMEDIATE WATER CURRENT

J.-M. BAEY, G. CHABERT D'HIERES, D. RENOUARD and H. DIDELLE
LEGI-IMG, B.P. 53, 38041 Grenoble cedex 9, France

Experiments are run on the 14 m diameter rotating platform to study the stability conditions for a constant volume flow rate current of intermediate water. The flow is introduced in a two-layer system in solid body rotation, along the sidewall of the tank, and then freely evolves. A sink allows to evacuate the intermediate water and ensures that the free surface height is constant (Fig. 1). Thus the initial conditions are the Coriolis parameter, the density difference (ρ_3-ρ_1) = O1‰), the layer thicknesses (the upper layer between 10 cm and 25 cm and the lower layer equal to 50 cm); the boundary conditions are the volume flow rate, the density, the initial width (L_0) and thickness (h_0) at the side of the intermediate current which is in geostrophic equilibrium when it leaves the source.

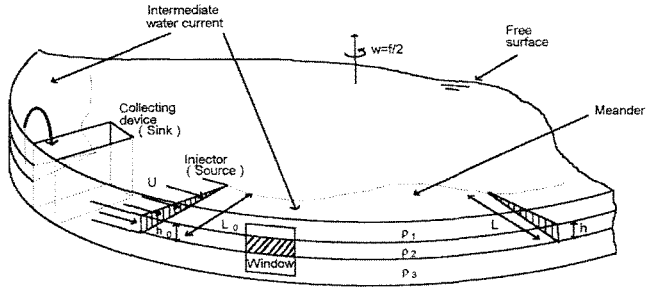


Fig. 1. Sketch of the experimental facility

The relevant parameters appear to be the Ekman number, $Ek_0=\upsilon(f.h_0^2)$, and Bürger number, $Bu_0=[(\rho_3-\rho_1).g.h_0/\rho 2](f^2.L_0^2)$, defined at the injector level. The data collected from the experiments are very consistent, and it appears as shown in figure 2 that there are five typical flow regimes : (1) a stable current along the whole basin, (2) a serie of cyclonic vortices attached to the wall, with an upstream stable current, (3) a large cyclonic vortex attached to an anticyclonic instability, (4) dipoles shed from the current into the interior fluid, and (5) generation of lenses of intermediate water, alike meddies.

When both the initial values of the Ekman and Bürger numbers of the intermediate water current are large (Ek_0= 16.7 x 10^{-4}; Bu_0= 6.71), then the current remains stable along the tank wall (namely the width of the current is constant) and during the whole experiment. For intermediate values of the Ekman number ($5.10^{-4} \leq Ek_0 \leq 10.10^{-4}$) there is a significant evolution of the current as Bu_0 increases. For small values of Bu_0 (Bu_0 = 0.45; Ek_0 = 6.7 x 10^{-4}), there are dipoles formation. First, a meander forms, then grows in diameter while becoming thinner near the wall, and finally separates from the vein. Another meander then appears at the same location, while the dipole drifts upstream. Then, for a higher Bu_0 (Bu_0 = 0.75; Ek_0= 7.4 x 10^{-4}) a dipole still forms, but stays attached along the wall, remaining at the same location near the injector. In that instance, the cyclonic pole is significantly more energetic than its anticyclonic counterpart and is located upstream of the anticyclone which remains close to the wall. For still higher values of the Bürger number ($3 \leq Bu_0 \leq 6$), there is an upstream portion of the intermediate water current which is stable, whereas in the previous cases the instabilities occurred shortly after the injector. The length of that stable part of the current increases with increasing Bu_0. Downstream that stable part there appears series of cyclonic vortices which remain attached to the wall. For the largest value of Bu_0 in this range of Ek_0 (Bu_0 = 10.8; Ek_0= 7.7 x 10^{-4}) the current is stable over all along the tank, as is the case for higher values of Ek_0. In all instances with a stable part of the current, we observe periodical cyclonic eddies in the upper layer, above the stable part. There is as well a vertical recirculation of water from the upper and lower interfaces into the core of the intermediate water current.

For the smallest values of Ek_0 (Ek_0=2 x 10^{-4}) and Bu_0 (Bu_0 = 0.25) obtained in this set of experiments, there is formation of anticyclonic lenses of intermediate water which separate from the main flow, and are thus comparable with meddies. The process is similar to dipoles formation described above. Such a possibility of "meddy" formation even in the absence of any topographycal discontinuity seems new.

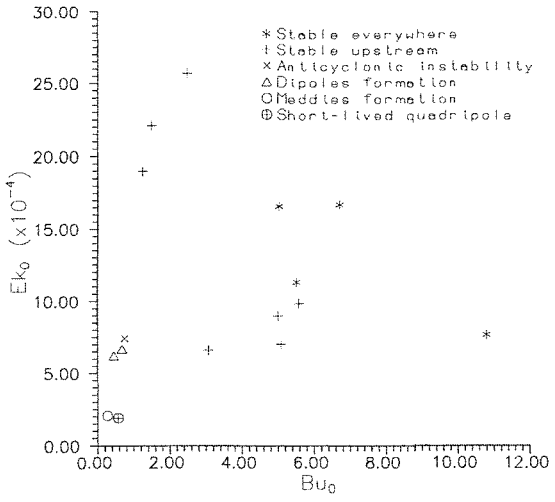


Fig. 2. Flow regime diagram.

This study was supported under Euromodel and E.P.S.H.O.M (Etablissement Principal du Service Hydrographique et Océanographique de la Marine) contracts.

ANALYSIS OF A ROBUST SIMULATION OF THE GENERAL CIRCULATION IN THE WESTERN MEDITERRANEAN

Jean-Marie BECKERS[1], Jacques C.J. NIHOUL[1], Joaquin TINTORE[2] and Alberto ALVAREZ[2]
[1] GHER, University of Liège, B5 Sart-Tilman, 4000 Belgium
[2] Universitat des les Illes Balears, Dept. de Fisica, 07071 Palma, Spain

The general circulation pattern of the Western Mediterranean is simulated using a primitive equation model (BECKERS, 1991) with daily mean atmospheric data, in the scope of the EU program EUROMODEL. In order to achieve a robust view of the circulation, assimilation of hydrological data is incorporated in the model by a simple relaxation mechanism towards monthly mean temperature and salinity fields computed by an inverse model (BRASSEUR, 1991) applied to the Western Mediterranean (BRASSEUR *et al.*, 1993).

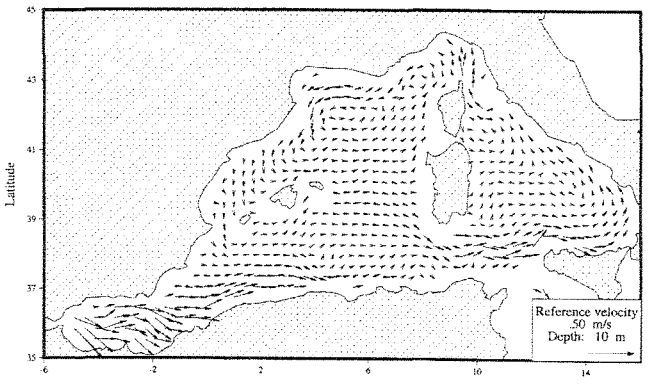


Fig. 1: Surface currents computed by the model at the end of February.

The simulation is then carried on in perpetual year conditions and the output of the simulations shows a general agreement with observational evidence : a Liguro-Provençal currents which is intensified during the winter, an Algerian current detached from the African coast during summer but closer to the coast in winter, general cyclonic circulation in the central basin and the Tyrrhenian Sea, deep water formation in the Gulf of Lions, signature of Levantine Intermediate waters, etc., are present in the model outputs (fig.1 & 2).

On the basis of these results, a diagnose of the operators in the mathematical model is performed in order to quantify the relative importance of wind forcing, thermohaline pressure gradients, diffusion and advection in the momentum equations. The evolution of these relative forcings is analysed in six different regions of the western Mediterranean and discussed in the light of seasonal variability of atmospheric forcings.

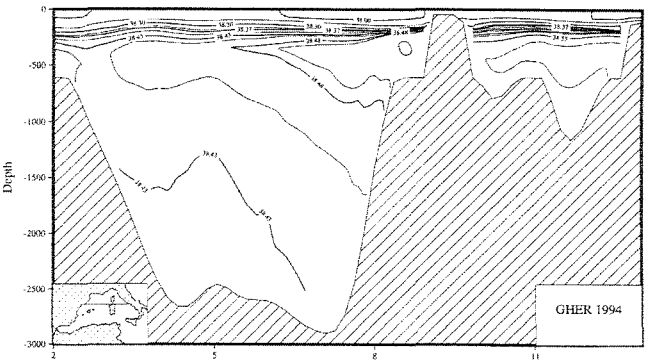


Fig. 2: Vertical section showing the northward flow of Levantine Intermediate Waters along the western coast of Sardinia.

Finally, the monthly mean sea surface heights are computed, as well as the variance in each month, which provides information about the mesoscale activity in the different basins.

REFERENCES

BECKERS J.M., 1991. Application of a 3D model to the Western Mediterranean. *Journal of Marine Systems*, 1, pp.315-332.

BRASSEUR P., 1991. A Variational Inverse Method for the Reconstruction of General Circulation Fields in the Northern Bering Sea, *Journal of Geophysical Research*, Vol. 96, No C3, pp. 4891-4907.

BRASSEUR P., BRANKART J.M., BECKERS J.M., 1993. Seasonal variability of the general circulation fields in the Western Mediterranean Sea : Inventory of climatological fields, Progress Report, Liège University.

NUMERICAL MODEL FOR THE WIND INDUCED CURRENTS IN THE KASTELA BAY

Gordana BEG PAKLAR and Branka GRBEC
Institute of Oceanography and Fisheries, Split, Croatia

The Kastela Bay is small semi–enclosed sea placed on the East Adriatic coast with total area of 61 km^2 and mean depth of 23 m. It has two openings; the wider one connects the bay with adjacent sea of the Brac Channel. The basin depths increase from the coast to the wider opening, reaching about 50 m.

The great influence of wind forcing on the Kastela Bay current field has been observed from the result of the several empirical analyses (ZORE–ARMANDA, 1980; GACIC, 1982).

Beside data analysis wind induced currents in the Kastela Bay were examined also by numerical hydrodynamical models. Heaps spectral three–dimensional model (ORLIC *et al.*, 1989) and non–linear three–dimensional multilevel model (BONE, 1993) were used to simulate currents induced by two most frequent wind systems bora (NE) and scirocco (SE). Results of the numerical experiments were compared with current meter measurements obtained in seven field experiment in period from 1980 to 1990. The best agreement between measurement results and model results of both models was obtained for the northernmost station in the bay centre. The comparison between empirical wind induced currents and model predicted results shows their poor agreement in the bay inlet during bora and scirocco wind. The magnitudes of measured currents were order of magnitude higher than modeled currents. Furthermore, the measurements and numerical model results for the current driven by bora are opposite direction in the bottom layer, while during scirocco wind current directions in these two cases were similar. There are several possible reasons for discrepancy between measured currents and currents obtained by numerical simulations in the bay inlet. First, the open boundary condition might be wrongly chosen. In the Heaps model radiation conditions in the opened boundary were chosen, while in the non–linear model zero elevation was assumed. Better results would be obtained involving realistic elevation at the open boundary. In addition, discrepancy between measurements and numerical results could be consequence of some nonlocal effect constrained on the bay inlet area. There are two possible process : northwest incoming Adriatic current could create density gradients in the inlet and therefore generation of gradient currents or discrepancy could be result of atmospheric pressure effect. Atmospheric pressure effect would be taken into consideration by involving realistic elevation at the open boundary. Both models assume spatial homogeneity in the wind field. The validity of this assumption should be checked.

In order to avoid discrepancy between empirical and model predicted currents caused by model limitations, in this paper the Princeton numerical ocean model was used (BLUMBERG AND MELLOR, 1987). This model contains an imbedded second momentum turbulence closure sub–model to provide vertical mixing coefficients, so theerrors coming from parametrisation of turbulence are avoided. The model uses sigma coordinate system, convenient in dealing with significant topographical variability such as that encountered in the Kastela Bay. Using the turbulence sub–model and sigma coordinate system, the model produces realistic bottom boundary model layers which are important in coastal waters and are often source of non-realistic modeled currents. Beside these two characteristics especially important in coastal areas such as Kastela Bay, model also includes complete thermodynamics with fully three–dimensional non-linear primitive equations and Boussinesq and hydrostatic approximation. The horizontal grid uses curvilinear orthogonal coordinates and staggered difference scheme called an Arakawa C–grid. The horizontal time differencing is explicit whereas the vertical differencing is implicit. The model has a free surface and split time step. The external mode portion of the model is two–dimensional and uses a short time step based on the CFL condition and the external wave speed. The internal mode is three–dimensional and uses a long time step based on the CFL condition and the internal wave speed.

In numerical simulations of the wind induced currents in the Kastela Bay by the Princeton numerical ocean model three elements are examined :

1) effect of the various open boundary conditions (radiation condition, zero elevation, realistic elevation obtained from tide–gauge registration);
2) effect of the density gradient in the bay inlet;
3) effect of the heterogeneity in the wind field.

The result of the numerical simulations are compared with averaged current vectors on three levels (surface, intermediate and bottom) obtained from seven current meter experiment from 1980 and 1990. Averaged current vectors were computed from low–pass filtered time series in the periods with filtered wind speed over 5 m/s. The numerical simulations and comparison with empirical data were performed for both bora and scirocco wind.

REFERENCES

BLUMBERG A.F., MELLOR G.L., 1987. A Description of a Three–dimensional Coastal Ocean Circulation Model. *In :* N.S. Heaps (Editor), Three Dimensional Coastal Ocean Models. *Coastal and Estuarine Sciences*, 4 : 1–16, American Geophysical Union, Washington, D.C.

BONE M., 1993. Development of a non–linear levels model and its application to the bora–driven circulation on the Adriatic shelf. *Estuar. Coast. and Shelf Sci.*, 37(5) : 475–496.

GACIC M., 1992. Notes on characteristics of the response of near shore current field to the on shore wind. Notes, 47 : 1–6.

ORLIC M., KUZMIC M., PASARIC Z., 1989. Modelling wind–driven transports in the Kastela Bay. UNEP Mediterranean action plan. Priority actions programme, Regional activity centre Split. 3A, 43 pp.

ZORE–ARMANDA M., 1980. Some dynamic and hydrographic properties of the Kastela Bay. *Acta Adriat.*, 21(2) : 55–74.

TIME DEPEDENT OPTIMAL MAPS OF THE POEM HYDROGRAPHIC SURVEYS OBTAINED THROUGH THE ADJOINT METHOD

A. BERGAMASCO[1] and P. MALANOTTE-RIZZOLI[2]
[1]Istituto Studio Dinamica Grandi Masse, C. N. R., Venezia, Italia
[2] Depart. of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, USA

The GFDL primitive equation model in its fully time-dependent non linear version has been used in the Eastern Mediterranean together with its adjoint to find the model state optimaly consistent with the model dynamics, the prescribed climatology, and which is steady in time. We now have used the adjoint method in its fully time dependent form, i.e. assimilating the data at the time and at the spatial location they were collected. We have produced time-dependent optimal maps for the POEM general surveys of ON85, MA86, AS87 and ON91.

This means that, starting from a first guess initial condition given by the climatology for the corresponding month (season) the hydrographic data (temperature/salinity casts at standard depth levels) are assimilated at the time in which the hydrographic station was actually taken and at the location (latitude, longitude) of the station itself. Thus, the cost function is constructed in a time dependent manner following the time space trajectory of the research vessel(s) during the surveys in the forward integration of the model. The adjoint is then integrated backward in time in the usual manner to modify the first guess initial condition. The procedure is iterated until the cost function has decreased to an "acceptable" level, where the measure of success is assessed through the examination of the final data misfits residuals (BERGAMASCO *et al.*, 1993). Thus, a time-dependent optimal map is reconstructed consistent with primitive equation dynamics and the specific hydrographic survey. We have optimally mapped the POEM surveys (ON85 through ON91) with the exception of MA87 in which data are too sparse. These time-dependent optimal maps will quantify in a definitive manner the space scales of the sub-basin and mesoscale structures of the eastern Mediterranean, their persistence versus variabilities.

O

SKIN AND BULK MEASUREMENTS OF SEA SURFACE TEMPERATURE IN THE SOUTH TYRRHENIAN SEA

M. BORGHINI[1], C. GALLI[1], M.E. SCHIANO[2], L. TAGLIACOZZO[2]

[1] Stazione Oceanografica - CNR, La Spezia, Italy
[2] Istituto di Fisica dell'Atmosfera - CNR, Roma, Italy

Measurements of skin and bulk sea temperature were made during several hydrographic cruises in the South Tyrrhenian Sea. Due to their small difference, both these temperatures are indifferently regarded as sea surface temperature. However, it was demonstrated that a vertical temperature gradient is needed to resist and regulate the fluxes of energy across the sea surface, and, therefore, its magnitude depends to the physical processes occurring at the ocean-atmosphere interface (SAUNDERS, 1967; KATSAROS, 1980)

In the Mediterranean Sea, where the air-sea interaction phenomena are very strong and the horizontal gradients of sea surface temperature are weak, it is important to analyse the differences between skin and bulk data.

The skin temperature was obtained using infrared radiometers mounted on the ship's bow at about 4 m above the sea level, while a towing thermometer was realized to measure the sea temperature in the first meter of the water column.

Together with the skin and bulk temperature data, are examined also atmospheric radiation measurements, contemporary recorded. The infrared radiation from the sky was chosen to represent the variations of the atmospheric conditions. Indeed, this parameter depends on the entire inhomogeneous atmospheric column. Its variability must be attribute to a change of cloud cover, humidity and air temperature profile. The heat fluxes from the atmosphere into the ocean strongly depend on all these terms. Thus, if the atmospheric radiation changes, there is a clear indication that must be changed the energy balance between air and sea. The interaction mechanisms between the two masses are not yet completely known, but evidently if one changes the other will try to adapt itself to the new conditions. For each mass the time required to do this and the intensity of the induced variation depend on the characteristics of the initial perturbation. On the contrary, the interface layer feels immediately any equilibrium change. Therefore light and short perturbations of one side don't disturb the other one, but influence the interface and the skin temperature will vary following all the modifications. Taking into account the sky radiation and the bulk sea temperature, the behaviour of the skin sea temperature was analysed in many different environmental conditions. The results show that in absence of significant variations of the air mass, the skin observations are in good agreement with the bulk samplings. The difference between the two temperatures remains nearly constant and horizontal gradients of sea surface temperature, even the smallest one, are detected in the same way by both the measurements. As soon as a change of the atmospheric conditions occurs, the skin data show oceanic features completely different from which inferable from the bulk observations and, in some cases, the data seem to be better correlated with the atmospheric radiation than with the temperature measurements of the water some centimetres below. This demonstrates that there is a temporal and spatial threshold beyond which the signature patterns obtained from radiometric measurements cannot be regarded as oceanic surface structures. Thus, satellite skin temperatures represent well the larger spatial scales of long-term and mesoscale ocean circulations, while small horizontal temperature gradients might be detected if only the horizontal distribution of heat and momentum through the surface is homogeneous .

It is also evident that the difference between bulk and skin temperatures must be taken into account to improve the calibration of infrared satellite measurements performing with *in situ* buoy data (ROBINSON *et al.*, 1984; SCHLUESSEL *et al.*, 1990). Moreover, the relation between the skin - bulk temperature difference and the heat flux were analysed.

REFERENCES

KATSAROS K. B., 1980, The aqueous thermal boundary layer, *Boundary Layer Meteorol.*, 18 : 107-127

ROBINSON I. S., N. C. WELLs and H. CHARNOCK, 1984, The sea surface thermal boundary layer and its relevance to the measurements of sea surface temperature by airborne and spaceborne radiometers, *Int. J. Remote Sens.*, 5 :19-45

SAUNDERS P., 1967, The temperature at the ocean-air interface, *J. Atmos. Sci.*, 24 : 269-273

SCHLUESSEL P., W. J. EMERY, H. GRASSL and T. MAMMEN, 1990, On the bulk-skin temperature difference and its impact on satellite remote sensing of sea surface temperature, *J. Geophys. Res.*, C 95 : 13341-13356.

STUDY OF THE SEASONAL AND INTERANNUAL VARIABILITY OF THE WESTERN MEDITERRANEAN BY MEANS OF LONG TIME SERIES OF AVHRR DATA

G. BORZELLI[1], S. MARULLO[2], R. SANTOLERI[3], M.E. SCHIANO[3]

[1] Telespazio S.P.A., Earth Observation Depart., Via Tiburtina 965, 00156 Roma, Italy
[2] ENEA/CR Casaccia, Via Anguillarese 301, 00060 Roma, Italy
[3] Istituto di Fisica dell' Atmosfera - CNR, Piazzale L. Sturzo 31, 00154 Roma, Italy

Until very recently, ocean studies using satellite data have concentrated on the instantaneous look provide by a single satellite pass. Recent studies of ocean basins using satellite data have used monthly and seasonal composite images of temperature at degraded spatial resolution (typically 10 NM) to show the more persistent events and changes that occur as results of basin-scale dynamics.

In this work a long time series of full resolution AVHRR images of the western Mediterranean sea are analysed together with a 10-year satellite data set of 18km/weekly scale to study the basin's seasonal and interannual variability both as indicator of the circulation variability and the long-term SST trends.

The analysis of one thousand of AVHRR images of the Western Mediterranean Sea, acquired in the period 1986-1992, has allowed to infer important conclusions on the main features and seasonal variability of the surface circulation of this basin and its sub-basins. The results have shown that the evolution of temperature in the western Mediterranean interacts strongly with regional surface circulation.

The low resolution data were used to study the SST seasonal and interannual variability. A spatial subdivision was carried out in order to distinguish sub-basins which are characterised by distinct dynamic as well as thermal pattern. Seven spatial areas were identified and for each of them time series of SST and main meteorological parameters were obtained and analysed together in order to investigate air-sea phenomena in the western Mediterranean Sea.

A comparison between the high and low resolution AVHRR data for the overlapping period have been done selecting nearly cloud free full resolution images representative of both summer and winter conditions for each sub-basin.

SEASONAL TEMPERATURE AND SALINITY FIELDS IN THE MEDITERRANEAN SEA : CLIMATOLOGICAL ANALYSES OF AN HISTORICAL DATA SET

P. BRASSEUR, J.-M. BECKERS, J.-M. BRANKART and R. SCHOENAUEN

GHER, University of Liège, B5 Sart-Tilman, Belgium

Observations of temperature and salinity have been collected in the Mediterranean Sea for a long time, within the frame of national and international research projects. An effort to merge several existing data sets into a common file system has been undertaken in the perspective of climatological studies. Up to now, over 25000 CTD and STD profiles have been integrated in the so-called MED2 historical data base, covering the period 1900-1983. These profiles originate essentially from the French BNDO (Bureau National des Données Océaniques, Brest) and the U.S. NODC (National Oceanographic Data Centre). The spatial distribution of the MED2 stations is shown on figure 1. This preliminary effort is now pursued within the frame of the CEC MAST/MODB initiative for data and information management. In the near future, the data bank will be upgraded with more recent data collected, for instance, by the POEM Group or by regional institutions.

Seasonal and monthly objective analyses of the original data are performed using a variational inverse method (BRASSEUR and HAUS, 1991) as an alternate to the standard statistical procedure. The solutions are derived from a variational principle, taking into account the statistics of the observations to minimize the expected error on the fields. Error fields are estimated from the variance of the finite element solution. In addition, a kinematic constraint can be imposed to represent anisotropic correlations between the data, as a result of the advection of the scalar properties by the geostrophic circulation.

The numerical parameters of the scheme are adjusted according to the statistics contained in the MED2 data. The results, materialized as gridded data sets (horizontal resolution at 1/4 of degree), show some trends of the seasonal variability affecting the properties of the water masses. As expected, the upper layer is the seat of a well-marked seasonal variability affecting both the temperature and the salinity fields. The surface salinity reconstructed for the winter period is illustrated on figure 2. The Rhode gyre in the Eastern basin and the Gulf of Lions gyre in the Western basin represent the most robust features of the winter circulation. An inventory of the seasonal analyses performed at all depths is reported in BRASSEUR *et al.* (1994).

The MODB products have been prepared for general distribution among the scientific community. In addition, they are conceived as a basic support to more advanced studies, including : diagnostic calculations, initialization of dynamical models, assimilation of hydrological data into primitive equation models, planning of experimental surveys, ... A first attempt to assimilate these climatological analyses into a 3D primitive equation model is reported in BECKERS *et al.* (1994). New versions of the climatological fields will be released as additional data are validated and made available to feed the MED2 historical data set.

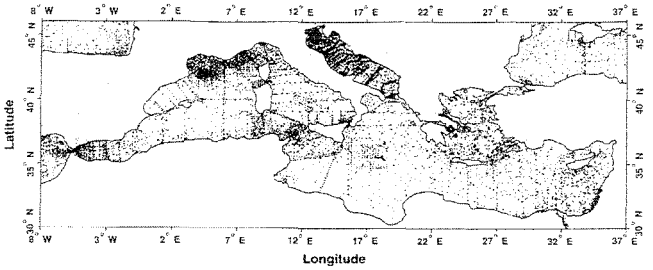


Fig. 1: Spatial distribution of the MED2 historical data during winter.

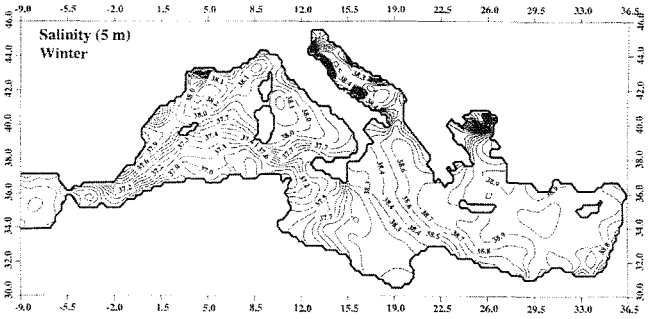


Fig. 2: Surface salinity representative of the winter season as reconstructed by the variational inverse method.

REFERENCES

BECKERS J.M., BRASSEUR P. and BRANKART J.M., 1994. Month-to-Month Variability of the General Circulation Fields in the Western Mediterranean Sea : Inventory of Simulation Results, Progress report, University of Liège.

BRASSEUR P. and J. HAUS, 1991. Application of a 3-D variational inverse model to the analysis of ecohydrodynamic data in the Northern Bering and Southern Chukchi Seas. *Journal of Marine Systems*, 1 : 383-401.

BRASSEUR P., BRANKART J.M. and BECKERS J.M., 1994. Seasonal Variability of General Circulation Fields in the Mediterranean Sea: Inventory of Climatological Analyses, Progress report, University of Liège.

EVALUATION OF HYDROLOGICAL BUDGET BY MEANS OF DIRECT CURRENT MEASUREMENTS IN THE STRAITS OF SICILY

G. BUDILLON, M. MORETTI, E. SANSONE, G. SPEZIE, E. ZAMBIANCHI

Istituto di Meteorologia e Oceanografia, Istituto Universitario Navale, Via Acton 38, 80133 Napoli, Italy

The meteorological events which force the dynamics of the individual subbasin of the Mediterranean yields variations in the stratification, which propagate at the typical speed of internal waves, i.e. very slowly. In other word, the Mediterranean is a system whose inertia acts so as to average the effects of a single meteorological situation and can be therefore considered as a sort of a climatological sensor.

Given the complexity of the Eastern Mediterranean basin, it is very difficult to identify criteria to quantitatively assess its variability. However, since the latter eventually expresses itself on the variability of AW (Atlantic Water) and LIW fluxes, it has proved convenient to look at it by measuring water mass transport in the Sicily Channel, where morphological characteristics make transport estimates easier.

The Sicily Channel represents the connection between the western and the eastern subbasins of the Mediterranean. At the surface in the western part of the Mediterranean, the flow is formed primarily by Atlantic Water which enters the Western Mediterranean through the Strait of Gibraltar and thereafter flows along the northern African coast, forming the Algerian Current.

The Algerian Current is characterized by intense associated mesoscale activity. This acts so as to divert a good portion of the AW from directly entering the Straits of Sicily, causing it to recirculate in the wide opening between Sicily and Sardinia, the Sardinia Channel. The path followed by the AW within the Channel exhibits considerable meandering, probably due to joint effect of direct dynamical forcing and conservation of potential vorticity in the surface.

The intermediate layer is, as can be expected, largely composed of Levantine Intermediate Water (LIW), which is always present in the region with a westward flow, slow but substantial in terms of mass transport. This has been clearly shown in the measurements collected by Istituto Universitario Navale over the last 8 years, which have revealed yearly variations with a quite well recognizable steady pattern through the maximum salinity topographies.

It is still not clear whether a presence of Eastern Mediterranean Deep Water is to be expected in the deepest region of the Channel : in particular, our measurements have not shown its presence, which might be confined, however, to relatively poorly sampled sub-areas.

As said above, the Sicily Channel is characterized by two layer situation, with the upper layer dominated by the AW flow towards South-East and LIW flowing in the opposite direction at lower depths.

In steady-state conditions, admitting salt and mass conservation in the Eastern Mediterranean, transport and mean salinities in the Channel are related to the water budget by :

$$Q(LIW) = \frac{D}{\rho_{LIW}} \frac{\langle S \rangle_{AW}}{\langle S \rangle_{LIW} - \langle S \rangle_{AW}} \qquad \frac{Q_{LIW}}{Q_{AW}} = \frac{\rho_{AW} \langle S \rangle_{AW}}{\rho_{LIW} \langle S \rangle_{LIW}}$$

Our attention were consequently focused on a section North-East of the Pantelleria Island, perpendicular to the axis of the Channel. It is known that the knowledge of the hydrology along a section allows to estimate only the baroclinic component of transports taking place in correspondence of the section itself; therefore, in order to transform these relative measurements into absolute values it is necessary to make some assumptions concerning the actual dynamics, which be justified in terms of the thermohaline structure of the studied area.

In the Sicily Channel the reversal of the flow clearly yields that a level of no motion has to exist, to separate opposite flow regimes. Once identified, this level of no motion will enable to evaluate geostrophic transports.

Our procedure to estimate transport across the Pantelleria section consists first of all of a preliminary evaluation of water mass and salt transport assuming the level of no motion to coincide with the 38.0 isohaline surface; thereafter, an adjustment of the level of no motion which takes into account, if necessary, flux imbalances and anomalies in the distribution of the physical-chemical characteristics. This procedure proves to be extremely sensitive, as the vertical velocity gradients at the interface between AW and LIW are large. Moreover, transport patterns can be way more complex than hypothesized ones; this yields that reaching a perfect salt transport balance is not always feasible at this stage of the computations. However this is not so crucial, given the linear relationship between salt and water mass transport, which allows to achieve the sought-after flux balance.

Our results are around 0.5 Sv, i.e. almost half as much as the generally accepted estimates drawn from indirect measurements, and even less with respect to the fluxes determined with direct methods; they show also a clear, roughly linear bond between salt and mass transport. This is due to the fact that the salt transport is approximately the product between mass transport and average salinity. Using this relationship we can then correct our salt transport estimates and compute the correspondent mass transport values, which will be more accurate as they satisfy mass continuity criteria.

It has to be underlined, however, that the dynamics of the Sicily Channel are characterized by mesoscale structures such as meanders and eddies with typical time scales between 3 and 10 days. These structures clearly constitute a kind of noise superimposed to the climatic signal, so that it is difficult to establish whether our estimates can be considered an accurate assessment of the variability of the climatic forcing.

This noise, however, can be filtered even by means of direct measurements of current. We performed that with good results using direct current measurements collected by Istituto Universitario Navale during the last year. The current meter mooring was positioned in the deepest sill (430 mt) of the Straits of Sicily where the flow of the LIW is expected to be more concentrated.

O

RECENT FLOW OBSERVATIONS IN THE STRAIT OF GIBRALTAR

Julio CANDELA and Richard LIMEBURNER[1],
Antonio Ruiz CANAVATE and Juan RICO[2]

[1] Woods Hole OceanographicInstitution, Woods Hole, MA 02543, USA
[2] Instituto Hidrografico de la Marina, 11007 Cadiz, Spain

A new two-year (April '94 - May '96) field program has been started to measure the exchange through the Straits of Gibraltar and Sicily in coordination with efforts from the European Community in the PRIMO-1 Program. This new effort concentrates on measuring the exchange through the Strait of Gibraltar, where current, conductivity, temperature, and pressure measurements are being made at two sites along the Strait axis, one at the sill (Camarinal) and the other at a section between Gibraltar and Ceuta at the eastern end of the Strait. These measurements are complemented by an array of four pressure sensors, also measuring conductivity and temperature, at Punta Camarinal and Tangiers across the sill section and at Ceuta and Algeciras. Two other pressure, conductivity and temperature sensors are deployed across the Strait of Sicily in Mazara del Vallo (Sicily) and Cape Bon (Tunisia) to complement PRIMO-1 current meter moorings deployed across the Strait of Sicily.

It has been more than eight years since the Gibraltar Experiment (Oct '85—Oct '86) ended, and still some of the important questions that it posed have not been properly answered. Most importantly :
(a) Is the hydraulically controlled exchange always maximal, or does it switch at times to a submaximal exchange state and if so, is this switching seasonal ?
(b) What is the best observational method to efficiently and continuously monitor this exchange state ?
and (c) How is this alternating state affecting the magnitude of the exchange between the Mediterranean Sea and the Atlantic Ocean?

This new field program is designed to address these questions, and also, by complementing the intense PRIMO-1 effort that is simultaneously focusing on the interior of the Mediterranean Sea, to appropriately address more global questions about the straits role in the Sea's circulation. Another important objective of the new measurements is to obtain accurate estimates of salt and heat fluxes occurring through the Strait of Gibraltar. These fluxes relate to integral climatic processes affecting the whole Mediterranean basin. For example, the salt flux at Gibraltar is a direct measure of net evaporation over the Sea, a measurement difficult to obtain from observations over the whole basin.

During this communication, we will present the preliminary results obtained from the first six months of deployment (April '94 - October '94) in relation to the overall objectives of this new field effort.

ADRIATIC SEICHE DECAY AND ENERGY LOSS THROUGH OTRANTO STRAIT

Ivana CEROVECKI[1], Mirko ORLIC[2] and Myrl HENDERSHOTT[3]

[1] Inst. Ruder Boskovic, Center for Marine Research, Bijenika 54, 41000 Zagreb, Croatia
[2] Geophysical Inst., Fac. of Science, Univ. of Zagreb, 41000 Zagreb, Croatia
[3] Scripps Institution of Oceanography 0209, University of California, San Diego, 9500 Gilman Drive, La Jolla, CA 92093-0209, USA

A salient feature of sealevel records from the Adriatic Sea is the frequent occurrence of energetic seiches with a period of about 21 hours. Once excited by a sudden wind event, such seiches may persist for days. They may lose energy either to friction within the Adriatic, or by radiation through the Straits of Otranto into the Mediterranean. The decay caused by both mechanisms has been included in a one dimensional variable cross section shallow water model of the Adriatic. Friction is parameterized by the coefficient k appearing in the linearized frictional acceleration term - ku/h (where h is the depth and u is the shallow water along-basin velocity), and radiation through Otranto is described by the coefficient a appearing in the strait boundary condition z = auh/ (sqrt) gh in which additionally z is sealevel and g the acceleration of gravity. Repeated runs of the model delineate the dependence of model seiche decay time on k and a shown in the accompanying figure.

Actual decay times of the fundamental longitudinal mode seiche have been determined by constructing the decay envelopes of sealevel (detided and subjected to a narrow band filter of width .0375 oph centered around the seiche frequency) from three locations (Bakar, Split and Dubrovnik) along the Croatian coast during twelve seiche episodes between 1963 and 1986, and taking into account only those portions of the envelopes which decrease exponentially in time and for which the modeled effects of along-basin winds were smaller than the error of estimation of decay time from the envelopes and the effects of across-basin winds were small. The average decay time thus obtained was 3.2 +/- 0.5 days.

For the model to reproduce this observed decay time with no energy loss through Otranto, a friction coefficient of k = .00067 m/s was needed; to reproduce the observed decay time with no friction, a coefficient of energy transmission of a = .064 was required. To proceed further, an estimate of k that is independent of observations of seiche decay time is required. ORLIC *et al.* (1986) estimate k = .00113 - .00124 m/s by balancing surface and bottom stresses in wind driven currents in the Northern Adriatic; ORLIC (1987) estimates k = .0006 - .00153 m/s from the observed decay time of near-inertial oscillations in the Northern Adriatic. The corresponding values of a needed for the model to reproduce the observed seiche decay time are zero to 0.0085; these imply the loss of zero to 3.3% of the seiche energy to the Mediterranean every seiche period. Since the decay time might be as short as 2.7 days, a could be as great as .02; in this case 7.8 % of the seiche energy would be lost to the Mediterranean every seiche period.

REFERENCES

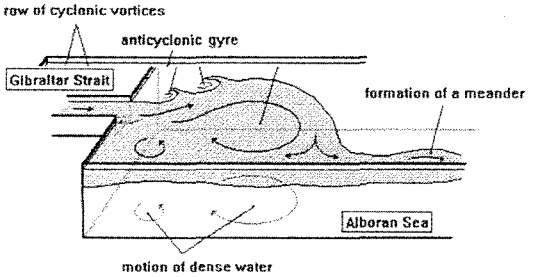
ORLIC M., 1987. Oscillations of the inertial period on the Adriatic Sea Shelf. *Cont. Shelf. Res.*, 7: 577-598.
ORLIC M., Kuzmic M., and Vucak Z., 1986. Wind-curl currents in the Northern Adriatic and formulation of bottom friction. *Oceanol. Acta*, 9 : 425-431.

SOME LABORATORY RESULTS ABOUT FLOWS BETWEEN GIBRALTAR AND SICILY STRAITS

G. CHABERT D'HIERES, H. DIDELLE, P. GLEIZON and D. OBATON
LEGI-IMG, B.P. 53, F-38041 Grenoble Cedex 9, France

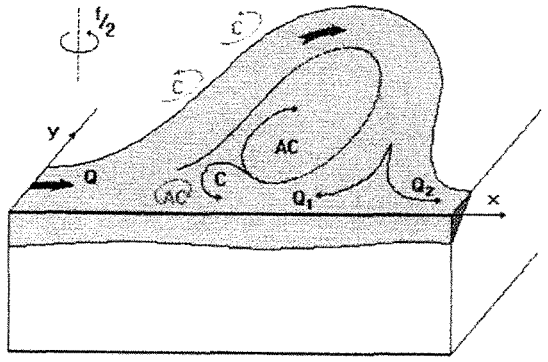
In order to describe, understand and simulate the circulation in the Mediterranean Sea, the Coriolis Laboratory conducted, for several years, some experiments in complement with the observation and numerical models. It is important to take into account the earth rotation in order to integrate, in a general circulation model, some mesoscale process for example : shear flow, currents, stratifications, instabilities... Using the large rotating platform of Grenoble gives us the possibility to approach the similitude according to the Burger and Ekman numbers. The most important results are developed within three items : Strait of Gibraltar, Alboran Sea and Algerian Current

Strait of Gibraltar and Alboran sea. The circulation of the water masses in the most western part of the Mediterranean Sea is characterized by some well-known features as the presence of one or two non-persistent gyres in the surface water (MAW). The flow is modelized in a rotating rectangular tank of 9 x 2 x 0.6 m, separated in two basins connected to each other by a strait. The currents are generated and maintained with the help of a hydraulic system using pumps. Owing to visualisation methods, the flow pattern is clearly put into evidence and data are gathered at the same time. The experiments reveal many important features of the currents in the strait. The most important of these are the presence of anticyclonic relative vorticity in each current and the capability of the strait to limit the exchange. The data show that there is a good correlation between the maximal exchange and the hydraulic control. This study needs further investigation, especially to evaluate the importance of geostrophic control on this process.



In the basin related to the Alboran Sea, the formation and the growth of an anticyclonic gyre has been observed. Its structure and "stability" appear to be dependant on the regime of the strait flow in a deterministic sense. In particular, they are widely dependant on the ratio of the internal radius of deformation to the width of the strait. The magnitude of the flow rate of the "atlantic" current does not change the structure of the flow, but modifies the growth time of the gyre. The flow can be considered as a superposition of many phenomena which can be study individually.

Algerian Current. The stability of a surface boundary current which flows over stationary denser water in a rotating system is studied in the laboratory. The current has constant flow rate and uniform velocity at its source. The gravity current can either be stable or unstable depending on the value of some of the non-dimensional numbers governing the flow. It has been seen that whatever the value of the Burger number is ($0.15 \leq Bu \leq 0.82$), the flow is unstable when the vertical Ekman number is smaller than $3\ 10^{-3}$ and stable above. The value of the ratio of the current thickness to the total depth can also be important. However, the effects of changing this parameter and the Ekman number has not been studied yet.



The instability degenerates into one or several meanders composed essentially of an anticyclonic eddy within the current and a cyclonic eddy at the front. Smaller the Ekman number is, more numerous the meanders are. They grow within the current being fed downstream by the current itself. At the same time, they move within the flow in the same direction. As their size increase, the interface moves downward below them. This result is in very good agreement with *in situ* measurements of the Algerian Current. Finally, although modeling is schematic, we obtain some goods results according with the observations and numerical model.

This study was supported by EUROMODEL in the frame of MAST I-II programs.

REFERENCES

FARMER D.M., ARMI L., 1988. The flow of Atlantic water through the strait of Gibraltar, *Prog. Oceanog.*, 21 n°1 : 1-71.
McCLIMANS T.A., GREEN T., 1982. Phase speed and growth of whirls in a baroclinic coastal current. River and Harbour Laboratory Report. STF60 A82180, Norvège.
MILLOT C., 1991. Mesoscale and seasonal variabilities of the circulation in western Mediterranean, *Dyn. Atmos. Oceans*, 15 : 179-214.
OBATON D., 1994. Etude expérimentale de la stabilité d'un courant de gravité. Application au courant algérien. Thèse de Doctorat UJF, Grenoble I.
SPEICH S., 1992. Etude du forçage de la circulation océanique pour les détroits. Cas de la mer d'Alboran. Thèse de doctorat PARIS VI.
GLEIZON P., 1994. Formation et stabilité de tourbillons anticycloniques engendrés par un courant barocline issu d'un détroit. Application à la mer d'Alboran. Thèse de Doctorat UJF, Grenoble.

SEA SURFACE TEMPERATURES AND CIRCULATION PATTERNS AT THE AEGEAN SEA USING AVHRR DATA

A. P. CRACKNELL[1], K. ABDULLAH[1],
J. N. HATZOPOULOS[2], M. KARYDIS[2], D. GAZIS[2]
[1] Department of Applied Physics Electronic & Manufacturing Engineering
University of Dundee, Dundee DD1 4NH, Scotland
[2] Department of Environmental Studies, University of the Aegean. Mytilene, Greece

This paper presents results from a joint project between the University of Dundee and the University of the Aegean. The project deals with the monitoring of the quality of the sea water environment using *in situ* measurements and satellite image data (CRACKNELL *et al.*, 1994). Part of the project was to analyse AVHRR images of the Aegean Sea because of their capacity for providing large area coverage of regional information regarding sea surface temperatures (SST) and circulation patterns. This information will provide more understanding of local marine process.

AVHRR scenes captured on 4 March 1992 and 5 June 1992 were acquired from the Dundee Satellite Station. Two AVHRR scenes captured on 11 July 1992 and 28 August 1992 were purchased from the National Remote Sensing Center Limited, United Kingdom.

Each sub-scene measuring an area of 512 by 512 pixels was extracted from each AVHRR scene which covered the sea water region of approximately between latitudes 27°N to 41°N and longitudes 23°E to 27°E including the Aegean Sea, Mytilene Sea and Saronikos Bay. The NOAA-11 Multi-Channel Sea Surface temperature (MCSST) algorithm was used for computing the SST value at each AVHRR pixel location. The land and cloud areas were masked out. The generated SST images for all the sub-scenes are shown in Figures 1 to 4 and were colour coded for displaying temperature values.

On all image dates the sea water south of Lesvos was relatively warmer than in the north. In the central area of the Aegean Sea the surface temperatures were relatively cooler than the surrounding areas on all scenes. This might be due to a cold current coming through the Dardanelia Strait towards the Aegean Sea. This cold pattern extending southward became progressively warmer with the distance southward.

The effect of land masses (islands) was observed in the SST images.Observation of the temperature images reveals that the temperatures south of these land masses were generally higher than the SSTs of the northern part of these land masses. This could be due to the north facing coastal waters being more exposed to the southerly flowing cool current whereas the south facing coastal waters were protected from this current. During the summer months the July and August scenes show higher SSTs as compared to the June surface temperature.

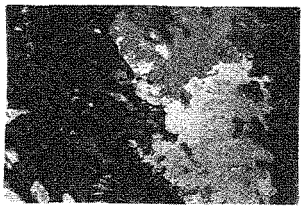


Figure 1. Temperature Distribution (°C) on 4 March 1992. Colour code: Dark blue<10; light blue 10-11, dark green 11-12; light green 12-13, yellow 13-14; orange 14-15; red>15.

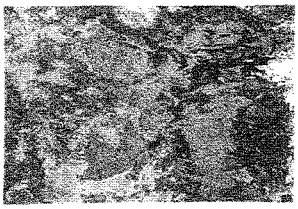


Figure 2. Temperature Distribution (°C) on 5 June 1992. Colour code: Dark blue<18; light blue 18-19, dark green 19-20; light green 20-21, yellow 21-22; orange 22-23; pink>24.

Figure 3. Temperature Distribution (°C) on 11 July 1992. Colour code: Dark blue<21; light blue 21-22, dark green 22-23; light green 23-24, yellow 24-25; orange 25-26; pink>27.

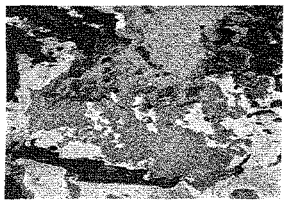


Figure 4. Temperature Distribution (°C) on 28 Aug. 1992. Colour code: Dark blue<22; light blue 22-23, dark green 23-24; light green 24-25, yellow 25-26; orange 26-27; red>27.

REFERENCES

CRACKNELL A.P. K. ABDULLAH, J.N. HATZOPOULOS, M. KARYDIS and D. GAZIS, 1994 : Monitoring for Protection of the Marine Environment Using Landsat TM and AVHRR Data, Final Report to the British Council of Athens Greece.

MARINE ENVIRONMENTAL DATA BASE OF THE ADRIATIC SEA (MAIN RESULTS FROM TIME SERIES ANALYSIS)

Vlado DADIC and Branka GRBEC

Institute of Oceanography and Fisheries, Split, Croatia

A hydrographic material collected from the Adriatic (ZORE-ARMANDA *et al.*, 1991) by different institutes between 1911 and 1993 is presented. It is stored in MEDAS (Marine Environmental Database of Adriatic Sea) in Institute of Oceanography and Fisheries. Database has designed as relational using ORACLE RDBMS, and consists data of climatology, physical oceanography, chemistry, biology, fisheries and pollutants. Data related to air temperature, evaporation, sea temperature and salinity were statisticaly processed and analysed. Constant fluctuation trends (increase and decrease) for most of the parameters indicate human impact on the sea water properties both in the coastal area and in the open sea. Output data are presented in GIS (Geographical information System) form.

The description of hydrographic properties is primarily based on the data from permanent station at the Split-Gargano transect located along the Palagruza pit and in this region the impacts of both the northern and southern Adriatic waters are felt. Data of air temperature, pressure, and precipitation from some permanent meteorological station (station Trieste, Split and Dubrovnik) were used to interpret the long-term fluctuations of sea temperature, salinity and evaporations both in the coastal area and in the open sea. Main trend analyses are presented in Fig. 1. Long-term variations show the linear trend of air temperature of + 0.14 0C/100 year, trend of daily amount of precipitation of -0.30 mm/100 year. Curve of long-term salinity variation at Split-Gargano transect shows the increasing trend. This trend is evident also at the Kastela Bay coastal station.

Using some statistical method like Principal Component Analysis (PCA), time series of air temperature, sea temperature, pressure, precipitation and salinity were compared for coastal and open sea separately. Analysis allowed determination of main component important for variability of analised climatic-oceanographic filed on secular time scale.

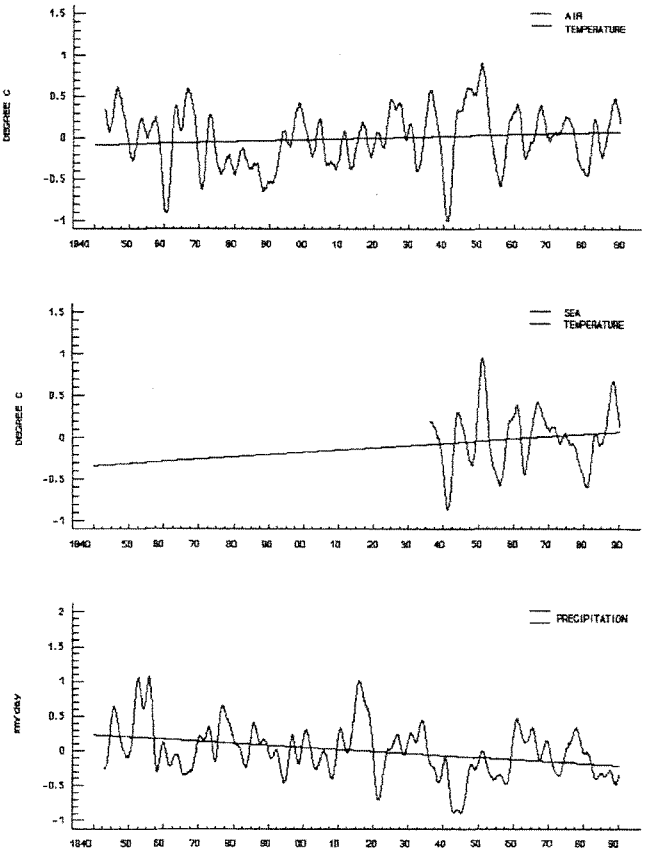


Figure 1. Monthly mean time series filtered by 24M214 for station Trieste (northern Adriatic) for period 1840 - 1990

REFERENCES

ZORE-ARMANDA, M., M. BONE, V. DADIC, M. MOROVIC, D. RATKOVIC, L. STOJANOSKI and I. VUKADIN, 1991. Hydrographic properties of the Adriatic sea in the period from 1971 through 1983. *Acta Adriat.* Vol. 32, 1 : 1-547.

MODELLING OF THE WIND DRIVEN CIRCULATION IN THE GULF OF LIONS

Stéphane DELEVILLE[1], Claude MILLOT[1] and Laurent MORTIER[2]

[1] Antenne C.O.M, B.P. 330, La Seyne-sur-mer, France

[2] LODYC, Université de Paris 6, Paris, France

The Gulf of Lions is characterized all year long by the occurrence of gusty winds (the Mistral and the Tramontane) which, being constrained by the orography, blow from a constant direction (the North and the North-West resp.). As shown from both *in situ* and remotely sensed data (MILLOT, 1979) as well as from former numerical models (HUA, 1981) and specific analyses (CRÉPON *et al.*, 1984) dealing with summer conditions, the upwelling mainly occurs along straight 10-20 km segments of the coastline while the bottom topography doesn't play a major role. This semi-circular gulf is also under the influence of the Northern Current which continuously flows along the continental slope (i.e. along its diameter) and spreads over the shelf when the winds stop. Modelling such an area is thus relatively easy and useful to better understand the circulation in wider areas of upwelling such as North-West Africa, Peru,...

In this work, which is part of the EUROMODEL contribution to the MTP of MAST-2, we use the 3D primitive equations numerical model of LODYC with a cartesian grid and a quite realistic coastline. The domain, extending from Cap de Creux in the South-West to cap Sicié in the North-East (i.e. 300 km x 240 km) is such that a newtonian restoring on initial values of tracers and dynamics is used along the open boundaries to damp inertial waves. Due to the space scale of the phenomena and to the value of the internal radius of deformation (~ 9 km), the horizontal grid size is 3 km. The preliminary computations presented here are done with a constant depth of 100 m. For these particular studies, the model has a vertical resolution (15 levels) ranging from a few metres, allowing a correct representation of the mixed-layer and the thermocline (which has mean depth and thickness of 30 m and 10 m resp.) up to a few tens of metres at depth. These computations have been made with very simple wind conditions (direction of a Tramontane-like wind, constant speed of 9 m/s starting from rest), temperatures of 20°C in the mixed layer and 13°C at depth, and without any general circulation.

After three inertial periods (about 3 x 17.5 h), which is a characteristic time scale for the summer gusts of wind, the distribution of the surface temperature is very similar to the commonly observed one. Upwellings are obviously located along the coast on the left of the wind, and mainly along the straight coastal segments, thus showing a marked discontinuity due to the coastline geometry. The intensity is also different from one upwelling to another, with the lowest temperatures encountered near the coast ranging from 4°C to 5°C below the initial surface temperature. All these features are in good agreement with *in situ* and remotely sensored observations.

The circulation in the surface layer forms an eastward coastal jet of ~50 cm/s along the northern coast. Capes located on the windward side of the the straight coastal segments induce a very local intensification of the jet. In the central part of the gulf, the wind driven circulation is almost on the right hand side of the wind. At the bottom, the coastal circulation is characterized by a westward jet along the northern coast and a northward one along the western coast, each being of a few cm/s. Due to the very large theoritical depth, the currents in most of the gulf are non significant. Most of these features are in agreement with the available observations.

After this study of the effect of a Tramontane-like wind, some experiments will be run with a Mistral-like wind and then with a combination of both. We wants to analyse the effects of the wind strength by increasing its speed (from ~9 m/s to ~15m/s). Some experiments will be done with a time depending wind to see the role of the succession of the gust of winds in the formation of upwellings and this study will end with actual wind fields, provided by meteorological numerical models such as PERIDOT.

This study is a part of a program of modelling the seasonal and meso-scale variations of the circulation in the Gulf of Lions: we want to study the interactions with the general mediterranean circulation (HERBAUT *et al.*,1994).

REFERENCES

CREPON M., C. RICHEZ and M. CHARTIER, 1984. Effects of coastline geometry on upwellings, *Journal of Physical Oceanography*, Vol.14, 8 : 1365-1382.

HERBAUT C., L. MORTIER, M. CREPON, 1994. A sensitivity study of the general circulation of the Western Mediterranean Sea. Part I : The response to density forcing through straits. Submitted to *Journal of Physical Oceanography*.

HUA B.L., 1981. Modélisation numérique d'upwellings côtiers à l'aide d'une méthode d'éléments finis. Application au Golfe du Lion. Thèse d'état Paris 6, 213 pp.

MILLOT C., 1979. Wind induced upwelling in the Gulf of Lions. *Oceanol. Acta* 2, 3 : 261-274

OBSERVATIONS AND MODELIZATION OF THE RHONE RIVER PLUME

J.-L. DEVENON and A. BAECKEROOT

Laboratoire de Sondages Electromagnétiques de l'Environnement Terrestre, (LSEET), UA 705 CNRS, Université de Toulon et du Var, BP 132 83957 La Garde Cedex, France

It is often observed that the Rhone river discharge in the Mediterranean sea takes the form of a buoyant surface plume of brackish water spreading horizontally far off-shore over a few tenth of kilometres. In the majority of cases, the river water is found to preserve its individuality on fairly great distances off-shore, and is accordingly confined in a thin layer floating over the underlying sea water. This freshened tongue of brackish water is vertically separated from the ambient marine water by a sharp halocline (thickness of a few metres). It is partially surrounded by an hydrological front with a marked contrast in salinity values on each side, and which is sometimes visible from a boat as a foam line separating the two water masses of different appearance (colour, surface roughness). This front is also a zone of high dynamic horizontal gradients since a frontal convergence of surface currents generally occur there, as evidenced on maps of radial components measured by the VHF radar, or by *in situ* drifter tracking.

The experiments operated by the LSEET laboratory off the Rhone mouth have provided a great amount of current data (one map every half an hour during two months) which could be combined sometimes with in situ observations, and from which a statistical analysis on various typical oceanic and meteorological situations can be well investigated. A morphological insight is provided every times the frontal boundaries of the plume are visible on such maps. Aside of this kind of information, different quantities such as radial acceleration or speeds of displacement of the whole structure can be calculated from one map to another. This gives access to orders of magnitudes for typical scales, both on a temporal and on a spatial point of view. One of the prominent feature is that the response of the system to a wind reversal can be quite fast (few hours), as it is often the case during transient events associated with sea breeze regimes, during while a high temporal variability is likely to occur. Another striking aspect of the phenomenon is its persistance and its approximately well defined location even during events of gusts of winds (Mistral). These are the situations on which we have decided to focus in a first step of a modelization approach.

A reduced-gravity non-linear layer model is developed in order to study river plumes. This stationary model, based on a simpler one found in literature (GARVINE, 1981), considers mass and momentum exchanges in the frontal zone. Interfacial friction has been introduced to take into account the wind and underlying current effects. Supercritical flow is assumed in the outlet channel, so that characteristics method is used for numerical resolution. It provides a variable grid, strongly akin with the flow properties. Finite difference method along characteristic lines and stream lines is used to solve the governing equations. Numerical stability is inherent to the model, as the grid verifies the Courant-Friedrich-Levy stability criterion. For a given accuracy the number of grid points is reduced by several orders of magnitude compared with a fixed orthogonal mesh grid. More over, this grid seems to be optimal for implementing data assimilation because the adjoint model and the direct model possess the same characteristics lines, so only a few additional computational time is needed.

The shape of the river mouth governs the initial expansion of the plume and its orientation. Near the river's mouth, the flow dynamics is mainly a balance between non-linear advective terms and the pressure gradient, whereas far off-shore the model tends towards an Ekman equilibrium. The wind appears as a major forcing term, and the computed flow is comparable with measurements made with the VHF radar of the laboratory near the Rhone's mouth.

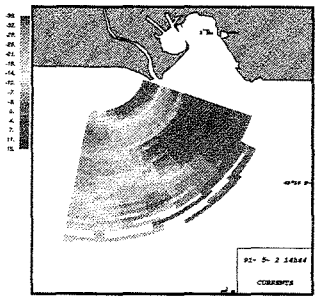


Fig 1: Radial components of sea surface currents (in cm/s) mapped by VHF radar during a Mistral event. Warm colors for currents receeding from the radar.

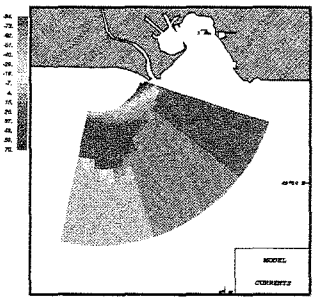


Fig 2: Modelized radial components of inside plume currents.

The agreement between the two kinds of results is mainly found on the basis of a morphological comparison. This is partly due to the ability of the model to restitute the frontal boundaries as lines of discontinuities. A quantitative comparison is specifically explored between the mean location of the plume for a given class of quasi identical meteorological forcing conditions and the model restituted location. Another analysis focuses on the comparison of accelerating terms which can be estimated from radar maps, to gain insight on the dynamic balance transcribed by the model equations; physical interpretations are looked for when discrepencies greater than the expected experimental inacurracies are found. Finally a detailed discussion is conducted concerning the parametrisation of the frontal mass and momentum exchange coefficients linked to the (observed) frontal velocity jump, and which will be probably chosen as model controls to be fitted in a future data-assimilation procedure.

REFERENCES

DEVENON J.-L., P. BROCHE, J.-C. de MAISTRE, P. FORGET, J. GAGGELLI, G. ROUGIER, 1992. VHF Measurements in the Rhône river plume, preliminary results, Water Pollution Research Reports, 28, Proceedings of 3rd Eros Workshop, Texel, The Netherlands.

FORGET P., J.-L. DEVENON, J.-C. de MAISTRE and P. BROCHE, 1990. VHF remote sensing for mapping river plume circulation, *Geophysical Research Letters*, 17 : 1097-1100.

GARVINE R.W., 1981. Frontal jump conditions for models of shallow buoyant surface layer hydrodynamics. *Tellus* , 33 : 301-312.

GARVINE R.W. 1982. A steady state model for buoyant surface plume hydrodynamics in coastal waters. *Tellus*, 34 : 293-306.

GARVINE R.W., 1987. Estuary Plumes and Fronts in Shelf Waters : A Layer Model. *Journal of physical oceanography*, 17 : 1877-1896.

SOME PHYSICAL OCEANOGRAPHIC ASPECTS IN THE NW COASTAL AREA OF MALTA

Aldo F. DRAGO

Marine Resources Network, MCST, Valletta, Malta

The Central Mediterranean is an exchange region between the western and eastern basins of the Mediterranean and presents an interesting case in physical oceanography with phenomena that are presently of great interest in current research. The Maltese Islands provide an obstacle to the main SSE vein of Atlantic water moving across the Sicilian Channel, and unpredicted coastal oceanographic aspects that are especially relevant to island systems and covering the full spectrum of temporal and spatial scales have been revealed. The present study is mainly based on the data collected during a survey in August 1992 with support from data acquired successively. Besides the survey undertaken in the subsequent Summer, short 3-day data collection campaigns during 1994 will allow the study of the seasonal variability. An intensive water current measurement programme is also being followed since mid-1993. An ENDECO water level recorder has become operative inside Mellieha Bay since mid-1993. A meteorological station set up at a coastal point in the area of study started data registration since April 1994. Fig. 1 shows the PVD from hourly averaged water currents at Ahrax Station, measured by a taut-wire moored instrument at 6.3 m from the sea bed and in a total depth of 34.9 m. This station is positioned mid-way between the main headland at Ahrax Pt. and the White Bank (see insert) which shoals steeply to the NE, reaching depths as low as 11m. The Eulerian transport follows a SE-NW axial pattern and is dominated by diurnal current fluctuations and reversals that are modulated by longer-period signals. The PVD zoom shows in detail the frequent sharp rotations of the current vector, with both clockwise and anticlockwise changes in flow directions. This characteristic water current pattern is accompanied by an oscillation of the seasonal thermocline, and is found to persist even during the winter months when the near-coast water column has no stratification.

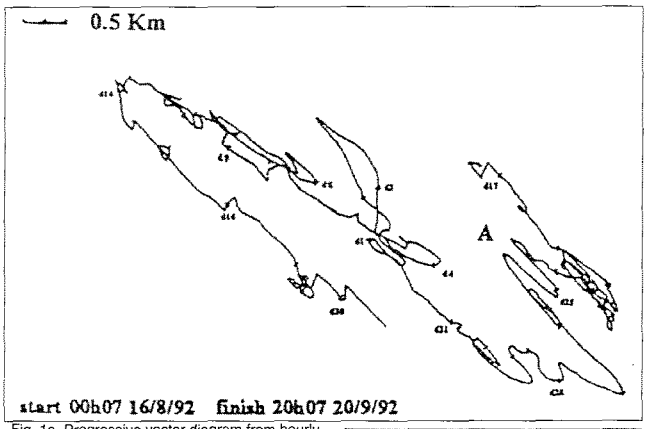
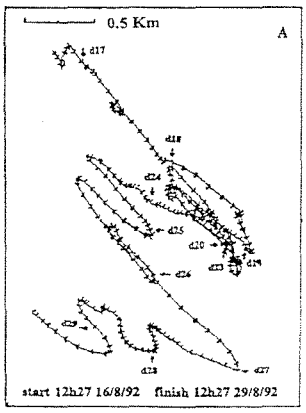


Fig. 1a. Progressive vector diagram from hourly averages current vectores at Ahrax station.
Fig.1b (right). PVD zoom of section marked A on fig. 1a.



Towards the higher frequency end of the spectrum the current regime is also affected by a strong seiche which pervades the whole coastal area around the Maltese Islands, often masking completely the small semi-diurnal astronomical tide, and causing water body movements with very short time periods of the order of 20 minutes. Subsurface currents observed by an ENDECO tethered current meter inside Mellieha Bay are found to follow cycles of much the same order, with a rapid reversal of the current vector over a matter of a few minutes. Direct wind forcing is excluded because such currents are present even on very calm days; the magnitudes can often reach 10cms-1 even at points close to the head of the bay and when the seiche is not particularly active. The water column inside the bay is homogeneous throughout the year so that any turbulent origin is also excluded. Such rapid changes in the current vector have been also detected by ADCP profiles. On the spatial dimension it is known, especially from remote-sensed data, that this area of the Mediterranean is very prolific in mesoscale phenomena that give rise to a system of intertwining frontal structures that reach close the islands. Wake-like streaks have been also observed to trail towards east behind the westernmost tip of Gozo, following well-defined swerving paths downcoast, capturing surface garbage and debris along their way. On a smaller scale, data collected in the coastal area of Mellieha Bay and St. Paul's Bay is revealing a complicated circulation in the surface mixed layer, with both the White Bank and the Ahrax headland acting as sources of negative vorticity. The effect of wind forcing on this circulation as well as the relation of its seasonal variability on the presence or eventual erosion of stratification, are all issues of current study. The Maltese archipelago presents itself in an ideal position in the area, acting as a large permanent research vessel in the region; also the advantage of a small tide permits the study of physical oceanographic phenomena that are often masked or contaminated in other areas with dominant tidal streams. Physical oceanography in Malta is still at its birth and the present work in this field of study represents a foundation for future investigations.

REFERENCES

ARTALE V., PROVENZALE A. & SANTOLERI R., 1989. Analysis of internal temperature oscillations of tidal period on the Sicilian continental shelf. *Contin. Shelf Res.*, 9, 10 :867-888.

DRAGO A.F., 1992. Long Period Sea Waves in the Grand Harbour, Malta. Marine Sciences Network, Technical Report 1, 1992.

DRAGO A.F., 1993. A Computer Software Application for an Acoustic Doppler Current Profiler. Proceedings Clean Seas Conference '93 (Malta).

GRANCINI G.P. & MICHELATO A., 1987. Current Structure and Variability in the Strait of Sicily and adjacent area. Annls. Geophys., 5B, 1, 75-88.

O

OCEANIC DATA ASSIMILATION IN THE MEDITERRANEAN SEA

P.G. DRAKOPOULOS[1], M. COOPER[1], K. HAINES[1], A. LASCARATOS[2], P. WU[1]

[1] Department of Meteorology, University of Edinburgh, King's Buildings Edinburgh, EH9 3JZ U.K.
[2] Department of Applied Physics, University of Athens, 33 Ippocratus Str., Athens, 10680 Greece

At University of Edinburgh a new technique has been developed for projecting altimetric data to produce deep ocean currents. The method is based on physical and dynamical conservation laws which ensure that water mass properties such as temperature, salinity and potential vorticity are preserved on isopycnal surfaces which remain below the mixed layer. These methods have been successfully tested on a simplified version of an eddy resolving Cox model for the Atlantic Ocean (HAINES, 1994). In this work we present results of applying this technique in a more realistic Cox model for the Mediterranean, using a twin experiment approach. The model which is eddy producing, has 0.25° x 0.25° horizontal resolution and 19 vertical layers and is forced seasonally (ROUSSENOV *et al.*, 1994). The assimilation run started 20 years after the spinup began and was integrated forward in time for one year. During assimilation time (every 10 days), the model density profiles were displaced vertically in response to observed surface pressure anomalies, in such way to allow geostrophic currents to decay with depth, thus avoiding unrealistic barotropic changes. Errors introduced in the density, temperature, salinity and velocity fields, mainly due to mesoscale eddy activity in the Levantine basin, the Alboran Sea and along the north coast of Africa have been successfully reduced at the end of the run (e.g. Fig. 1). Salinity and temperature errors were reduced by 50% and velocity by 40%. In addition, and despite the ventilation of certain isopycnals during water formation periods, potential vorticity error on these layers was also found to be improved.

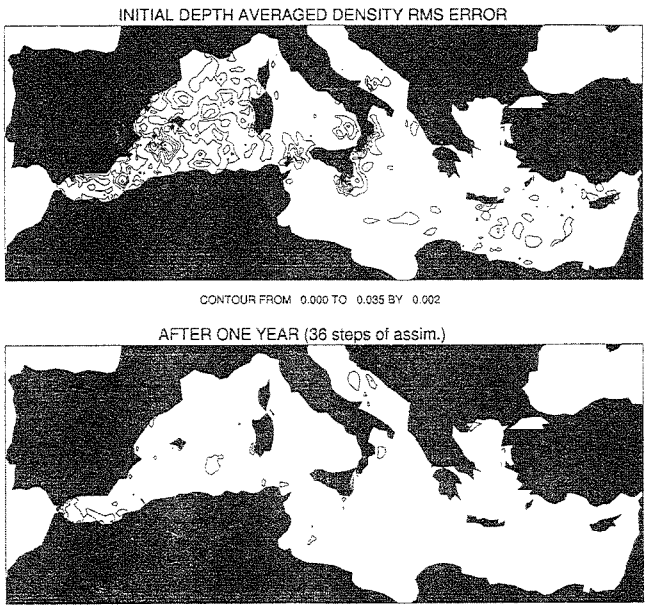


FIG 1: Density error (rms deviation from observations), at the start of the assimilation run and after one year of forward integration which included 36 steps of assimilation.

REFERENCES

HAINES K., 1994. Dynamics and data assimilation in oceanography, *in* Data Assimilation : Tools for Modelling the Ocean in a Global Change Perspective, edited by P.P. Brasseur and J.C.J. Nihoul, NATO ASI Series, Vol. I, 19, pp 1-32.

ROUSSENOV V., E. STANEV, V. ARTALE and N. PINARDI, 1994. A seasonal model of the Mediterranean Sea general circulation. In press on the *J. Geophys. Res.*

ESTIMATE OF THE CAPACITY OF NEARSHORE WATERS TO DISPERSE DISCHARGED EFFLUENTS

M. Hany S. ELWANY[1] and John REITZEL[2]

[1] Center of coastal studies, Scripps Inst. of Oceanography, La Jolla, CA 92093, USA
[2] Oceanographer, 763A Tourist Park Rd., Halifax, PA 01732, Canada

Full-scale prediction of the spatial-temporal distribution ofeffluent concentration around a discharge in nearshore watersrequires extensive plume-modelling applied to a variety ofreceiving-water conditions representing the long-term statistics ofcurrents and density stratification. As a preliminary step, it is useful to have a rough estimate of the spatial distribution of vertically-averaged long-term mean concentration of effluent, to predict the ranges along and across the shelf over which the effluent may have appreciable effects on the environment. This kind of rough estimate may be obtained by treating the matter as a diffusion problem, with time-varying diffusivity estimated from the autocovariance functions of long local current records.

In principle, an accurate estimate of long-term diffusivity can only be made from the Lagrangian autocovariance of the velocities of a large set of drifters or dye-marks released from the same point at random intervals over a long period of time (taking the time as zero at the release of each drifter), and not from the Eulerian autocovariance derived from a current-record at a fixed point. In the limit of small times, however, both kinds of autocovariance give the same-time varying diffusivities $K^i = w_i^2 t$, in which w_i^2 is the long-term variance of velocity in the i^{th} direction. The differences at longer times will not generally spoil a rough estimate.

To deal with a nearshore discharge over a sloping bottom, the diffusion problem may solved for a space in the shape of a long wedge, bounded by sea-bottom and the surface, with the apex at the shoreline. Taking the discharge as uniform from top to bottom allows the generally unknown vertical diffusivity to drop out of the solution, and gives vertically-averaged concentrations due to the total discharge. The solutions show concentrations directly proportional to discharge rate and inversely proportional to bottom slope, the long-term standard deviation of current velocity, and the square of the distance from shore to the discharge.

An estimate for a continuous cooling water discharge of 1000 m^3/sec (ELWANY *et al.*, 1990) into southern California waters, 2.5 km from shore with an average bottom slope of .006, gave long term mean concentrations of discharged water near the shore as about 9 parts per thousand 5 km alongshore from the discharge and about 5 parts per thousand at 10 km alongshore (Fig. 1). The effect of a long-term mean longshore current of 2.9 cm/sec was to displace the whole pattern of concentration about 2 km downcurrent (Fig. 2).

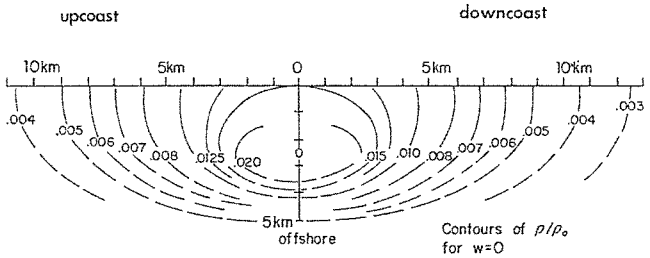


Figure 1. Contours of relative concentration ρ/ρ_0 with no mean current (W = 0)

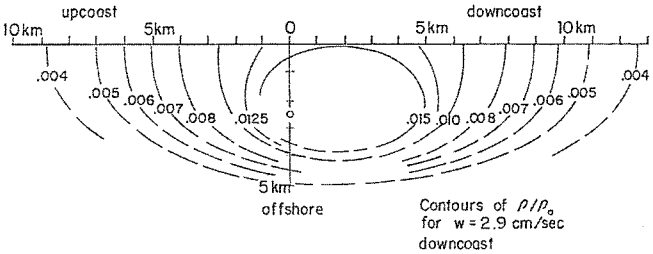


Figure 2. Contours of relative concentrations ρ/ρ_0 with for mean current W = 2.9 cm/sec downcoast.

REFERENCES

ELWANY, M. H. S., J. REITZEL and M. R. ERDMAN, 1990. Modification of coastal currents by power plant intake and thermal discharge systems. Coastal Engineering, v. 14 p. 359 - 383.

ANALYSIS OF THE LOCATION OF UPPER BOUNDARY OF THE H2S-ZONE FROM MULTIANNUAL DATA

V. N. EREMEEV, A. M. SUVOROV, A. K. KHALIULIN, E. A. GODIN

Marine Hydrophysical Institute, Academy of Sciences of Ukraine, Kapitanskaya 2, Sevastopol, Crimea, 335000, Ukraine

The problem of the hydrogen sulphide contamination of the Black sea is in the focus of attention of oceanologists and ecologists in view of the existing assumptions and some data on the rise of the anoxic water boundary to the sea surface and on possible catastrophic effect of hydrogen sulphide on human activity in the coastal zone. The estimates of dynamic of the upper boundary on the H_2S zone (UB of the H_2S zone) obtained up to present were based on the limited data array which did cover the whole population of measuring results accumulated. The work on mobilization and rescue of all accessible data has been done by us.

The correlation between the location of the UB of the H_2S zone and some physical surfaces in the Black sea was noted in a series of papers published in recent years. According to the opinions of many researchers (BEZBORODOV, 1989; VINOGRADOV, 1991) the correspondence of the UB of the H_2S zone to the certain, rather narrow isopycnic layer ($\sigma_{s,\,t,\,o}$ -16.20) is most demonstrative. However such a correspondence was observed, as a rule, within rather short time interval, most often during one voyage and over the limited areas. Research carried out by academic institutions of the Ukraine showed that in the Black sea there exists a relationship between the location of the definite isopycnic surface and the UB of the H_2S zone not only on meso-scales but also on climatic scales when computation is done using the multiannual averaged data. In computations averaged data over the period 1921-1993 years was used.

The coefficent of correlation between the location of the UB of the H_2S zone and the depth of the 16.2 isopycnal has been computed from the averaged data. The value of this coefficent was obtained to be equal to 0.71. It is noteworthy that the best correspondence between the location of the UB of the H_2S zone and the depth of the isopycnal is observed in the deep-sea region where the correlation coefficient reaches 0.88.

Thus the results obtained permit a conclusion that an interplay between location of the UB of the H_2S zone and the depth of isopycnal 16.20 can be traced not only witihin rather short time intervals (as noted previously) but also on the climatic time scales when using the averaged observation data for the entire basin.

On the basis of the studies implemented, the linear regression equations was deduced relating the location of the UB of the H_2S zone with the depth of the 16.20 isopycnal, which allows us to specify the depth of the upper bounday of the hydrogen sulphide zone in the squares in poor data coverage or in the periods when observations of the hydrogen sulphide concentration vertical distribution was absent.

Figure 1 shows the multiannual average variability of the depths of the UB of the H_2S zone (solid line) and of isopycnal with conventional density 6-16.2 (dashed line) for the Black sea basin. One can assume that these curves describe some global climatic process which has no constant trend. Apparently, the UB of the H_2S zone produces oscillatory movements in time with approximately century period. Comparing curves, one can conclude that the diagrams showing the location of the UB of the H_2S zone and the depth of the isopycnal agree well, which supports a corollary about the oscillatory character of variability of the UB of the H_2S zone.

The high correlation level between the location of the H_2S zone boundary and the elements of the density structure od seawater points to the dominant role of hydrophysical and hydrological factors in a totality of processes which govern its multiannual variability.

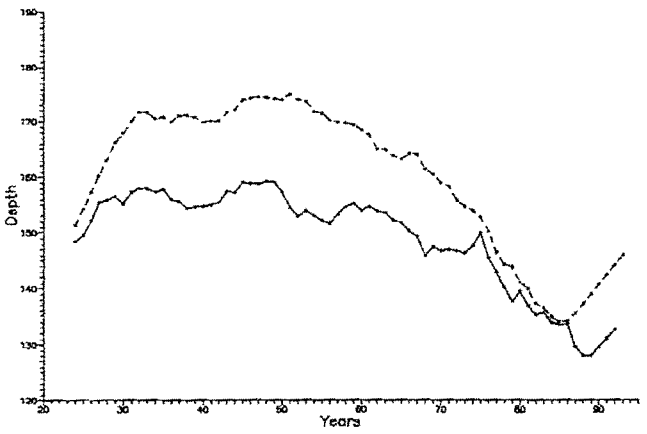


Figure 1. The multiannual average variability of the depths of the UB of the H23-zone (solid line) and of isopycnal 16,20 (dashed line).

SPATIAL ISOPYCNAL ANALYSIS OF SOME PROCESSES RESPONSIBLE FOR THE HYDROCHEMICAL STRUCTURE OF THE BLACK SEA WATERS

EREMEEV V. N., KONOVALOV S. K.

Marine Hydrophysical Institute, Academy of Sciences of Ukraine, Kapitanskaya 2, Sevastopol, Crimea, 335000, Ukraine

Scientific discussion on shoaling of the upper boundary of hydrogen sulfide zone and catastrophic degradation of the Black Sea environment is the reason of intensive investigation of the surface and undersurface Black Sea waters during the last ten years. Obviously, that scientists need some new methods to collect and to analyze samples of water, but more over they have to use new methods to analyze obtained chemical data.

Before the nearest time investigators usually analyzed the data on the hydrochemical structure of the Black Sea waters versus depth. In this way they could only conclude that intensity of the main cyclonic and anticyclonic gyres determine the main features of the chemical vertical structure. But it is very difficult to eliminate the influence of different gyres on a shape of the isopycnal surfaces, so this is extremely difficult to analyze the influence of chemical and biochemical processes, to analyze the real (cross-isopycnal) vertical fluxes of any chemical substances in this way.

Hydrochemists started to use intensively one-dimensional isopycnal analysis for investigation of the Black Sea chemical structure after American-Turkish cruise on R/V "KNORR" in 1988. The sigma-t scale rather then depth is used in this method. This one-dimensional method is very useful, but one needs to suggest that the intensity of different biochemical processes and crossisopycnal fluxes are equal for entire basin.

When some large data sets for entire Black Sea (obtained, for example, during "CoMSBlack" experiments) were analyzed, scattering of some hydrochemical parameters for equal values of density has been observed. This scattering was much higher then any possible analytical errors.

Spatial isopycnal analysis is very useful method for investigation of variations of hydrochemical structure. The most advantages will be received, if to use this method for investigation of highly stratified marine basins. In this way the influence of different hydrophysical and chemical or biochemical processes on the hydrochemical structure can be divided effectively.

We have used 2D-isopycnal analysis to understand and to investigate the main features of the spatial distribution of oxygen and hydrogen sulfide in different layers of water (on different isopycnal surfaces) and the main processes responsible for it. The significance of the winter ventilation processes over the main cyclonic gyres in the central part of the Black Sea for transfer of oxygen downward to the upper boundary of hydrogen sulfide has been indicated.

It has been confirmed, that sub-oxygen zone ("SO"), where concentrations of oxygen and hydrogen sulfide are less then 3 - 5mcM/l, with the thickness of 14 - 51 meters or 0.2 - 0.6 units of sigma-t is the permanent feature of the Black Sea hydrochemical structure. Analysis of spatial variations of the structure of "SO" zone has been carried out and some mechanisms responsible for it have been suggested. Spatial enter and interannual variations of hydrogen sulfide distribution versus sigma-t have been investigated on the basis of "CoMSBlack-91", "CoMSBlack-92", "CoMSBlack-93" data sets.

It has been shown that convectional ventilation over the main cyclonic gyres in winter time is responsible for destruction of the layer of nitrates' maximum (sigma-t ~15.4) and the upper phosphates' maximum (sigma-t ~15.6). This process can transfer a lot of nutrients into euphotic zone. It has been estimated for nitrates by value as much as ~200 000 tuns, what is equal to annual riverine inflow.

These winter ventilation processes can be the reason of intensification of oxygen - hydrogen sulfide interaction and, as a result, decreasing of phosphates in the layer of their minimum (sigma-t ~15.95) and increasing of phosphates in the layer of their down maximum (sigma-t ~16.20-16.30). The area of the sea, where all three extremes of phosphates can be observed in winter-spring period of the year is bounded by the Main Black Sea Flow.

O

DISTRIBUTION OF THE SURFACE AND INTERMEDIATE WATER MASSES INFERRED FROM THE XBT-THETIS 2 TRANSECTS ACROSS THE WESTERN MEDITERRANEAN SEA

Jean-Luc FUDA and Claude MILLOT
Centre d'Océanologie de Marseille, Antenne COM, BP 330, La Seyne/mer, France

The THETIS 2 experiment is conducted by IFM-Kiel, IACM-Heraklion, IFREMER-Brest and COM-La Seyne/mer within the framework of MAST 2 (SEND, 1995). Its aim is to check the capability of tomographic measurements to evidence large scale temperature variations in the western Mediterranean Sea. Among the 7 tomography moorings set in place for ~10 months in 1994 in the whole Algero-Provençal Basin, 2 have been positionned on the route closely followed by a tanker navigating between Fos/mer (~5°E, France) and Skikda (~7°E, Algeria). During that time, 24 calibrated XBT-T7 probes (accuracy of 0.05°C instead of 0.1°C; nominal depth ~760 m) have been launched, twice a month, every ~25 km between these two moorings. Beside the forthcoming tomography results, new valuable information about the distribution and variability of the Modified Atlantic Water (MAW), the Winter Intermediate Water (WIW) and the Levantine Intermediate water (LIW) has been collected which closely agrees with our schematic circulation diagrams (MILLOT, 1987) and analyses performed up to now. In the Gulf of Lions, the February sections were typical of the preconditionning phase of the Western Mediterranean Dense Water (WMDW) formation. A relatively cool (12.5-13.0°C) and thick (200-400 m) mixed layer was separated from below by a relatively thin (~100 m) thermocline (~0.5°C). Thereafter, due to exceptionally mild weather conditions, this whole surface layer was found, in mid-March, with a larger temperature (~13.1°C) before being entirely caped, in late March (fig.1), by an unusually warm (~13.5°C) superficial layer. Then, worse weather conditions occurred which led, in mid-April (fig.2), to a stratification similar to that encountered one month ago (mean temperature of ~13.1°C down to ~200 m). Even if the 25-km space scale is not sufficiently small to provide definitive information about mesoscale features, it is interesting to note that, during the whole experiment, the most homogeneous profile has been collected in mid-April. The North Balearic Front, which delimits the northward spreading of MAW in the Algerian Basin, is clearly evidenced near 40°30'N, mainly contrasting with the generally low stratification in the zone of dense water formation. From the beginning of May, the seasonal thermocline sets up, as usual.

According to our most recent analyses, WIW is cooled and homogeneized MAW which has been covered by less modified MAW advected from neighbouring places. Even if mainly formed in the northern part of the basin, it has been recognized by its temperature minimum in two specific places. One is just south of the North Balearic Front (~12.9°C at ~250 m) and often associated with an underlying lens of LIW, as if both water masses were entrained by a cyclonic rim current surrounding the zone of dense water formation. The other is in the Algerian Basin, where WIW appears as lenses with less low temperatures (~13.1-13.2°C). These lenses are supposed to have been entrained first from the Spanish continental slope to the Algerian one by the flow of recent MAW, and then in the interior of the Algerian Basin by mesoscale eddies.

Some of the LIW is distributed in a roughly similar way. In addition to its association with WIW south of the North-Balearic Front, LIW is found along the French continental slope clearly flowing westwards as a quasi-permanent vein (~13.4-13.5°C). The LIW having the less large temperatures, and thus expected to be the oldest and more mixed water, is generally found close to the Algerian continental slope. This clearly supports our recent hypothesis suggesting that, as WIW, LIW can be entrained too from Spain to Algeria, and then eastwards. Of major interest is the fact that the less-mixed LIW (up to ~13.9°C) is distributed in the interior of the Algerian Basin in the form of mesoscale accumulations (width sometimes greater than ~50 km, thickness up to ~200 m at 300-400 m). This distribution dramatically changes from one transect to the other (see fig.1 and 2). This LIW is relatively unmixed so that, according to our 1987 schematic diagrams, it is expected to have been entrained away from the Sardinian continental slope and then trapped by mesoscale eddies. In order to get more precise information about these accumulations, we presently take advantage of the return trip and launch, at a space scale as small as possible, standard XBT's.

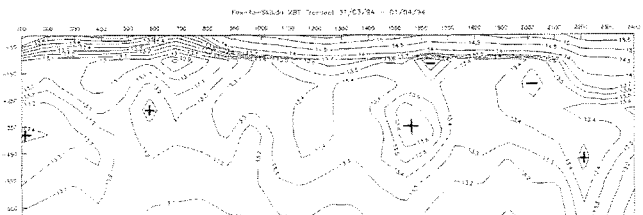


Fig. 1 : 31/03/94. XBT transect from ~5°E close to France (left-hand side of the figure) to ~7°E close to Algeria. Relative maxima (minima) at intermediate depths are noted by + (-).

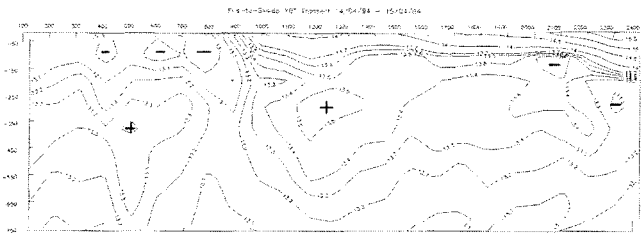


Fig. 2 : 14/04/94. XBT transect from ~5°E close to France (left-hand side of the figure) to ~7°E close to Algeria. Relative maxima (minima) at intermediate depths are noted by + (-).

REFERENCES
MILLOT C., 1987. *Oceanol. Acta*, 10, 2.
SEND U., 1995. *Rapp. Com. Int. mer Médit.*, 34.

SMALL SCALE FEATURES OF THE ALBORAN SEA CIRCULATION INFERRED FROM HYDROLOGICAL AND ICTHYOPLANCTONICAL DATA

J. GARCIA LAFUENTE[1], N. CANO LUCAYA[2], J.P. RUBIN[2] and A. HERNANDEZ GUERRA[3]
[1] Department of Applied Physics II, University of Malaga, Spain
[2] Instituto Español de Oceanografia, Malaga, Spain
[3] Faculty of Marine Sciences, University of Las Palmas de Gran Canaria, Spain

In July 1993, the "Instituto Español de Oceanografia" carried out the ICTIOALBORAN-93 survey in the Alboran Sea, performing 65 hydrographic (CTD) and biological stations. Figure 1 shows the dynamic topography (cm-dyn) of the surface referred to 200 db. The western Alboran anticyclonic gyre appears well developed while the eastern gyre is notoriously smaller. West of Cape Tres Forcas, a reduced area of cyclonic circulation was observed (area C, fig. 1). The T-S characteristics of the surface waters here suggest that they have been drawn away from the northern part of the Atlantic Current (AC), (zone B, fig. 1) where warmer and saltier surface waters are found in summer. This is confirmed by the analysis of fish larvae distribution of three mesopelagic species whose adults live in open sea between 200 and 1000 m depth. Two of them, *Benthosema glaciale* and *Maurolicus muelleri*, are abundant north of 36°N in the Alboran Basin, where their maxima larvae concentrations were found. However, a noticeable abundance of them was also found in the core of this cyclonic area, south of 36°N, and negligible amounts in the stations around it. The simultaneous lack of larvae of *Ceratoscopelus maderensis* in the core confirms additionally the intrusive nature of this small-scale feature, since these larvae were found all over the southern portion of the western basin, that seems to be their adult's habitat. The presence of this surface water here could be explained by a significative north to south cross-stream ageostrophic circulation in the vicinity of Cape Tres Forcas or, alternately, by barotropic instability of the AC forced by the local topography. The second hypothesis seems more probable since this small-scale feature is not regularly observed, which would be the case under the first assumption. The variability of the Alboran Sea anticyclonic gyres and the inflowing AC has been (and still is) widely investigated by means of field studies (CANO & CASTILLEJO, 1972), satellite imagery (HEBURN & LaVIOLETTE, 1990), numerical (PRELLER, 1986) and laboratory (WHITEHEAD & MILLER, 1979) models. There is a general agreement on the key role played by topography in configuring the gyres. The small Alboran island and the prominent Cape Tres Forcas, near 3°W, must have influence not only in the size and location of the Western gyre but on the formation and size of the Eastern one, for the AC enters the eastern basin following a path which lies between both of them.

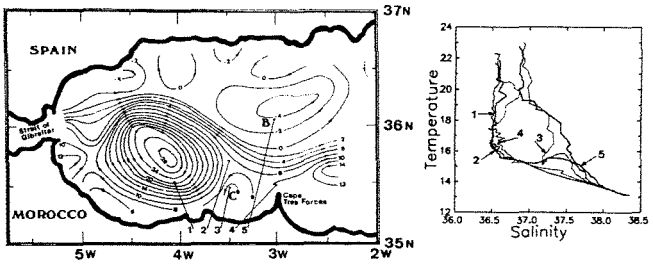


Fig. 1 (left). Dynamic topography of the sea surface referred to 200 db. Numbers 1 to 5 label hydrographic stations whose T-S diagrams are shown in fig.2.
Fig. 2 (right). T-S diagrams. The arrows identify the stations and indicate the depth of 50 m.

Satellite imagery is a powerful tool to study the time variability of the gyres, provided that the surface thermal structures reflect the underlying dynamics. HEBURN and LaVIOLETTE analyzed a considerable set of images from the years 1982 and 1986. All of the images belonged to one of the three situations sketched in figure 3, the simultaneous absence of both gyres never being observed. From the results of their analysis it is not possible to elucidate which is the most likely situation; the actual situation seems to evolve continuously. The path of the AC in the Alboran Sea can be modelled as a baroclinic Rossby wave strongly modified by topography, which reduces its "natural" length-scale to make it fit into the basin (PRELLER 1986, HEBURN & LaVIOLETTE, 1990). From this point of view, situation 3-a seems more unstable than either 3-b or 3-c, due to the strong curvature of the stream in the southern meander. For instance, what would happen if conditions in the inflowing Atlantic Water (AW) through the Strait of Gibraltar were changed and the size of A_1 increased ? Part of this AW should remain inside A_1 and, as it grows up, the curvature of the Jet near Cape Tres Forcas would be emphasized, favouring barotropic instability and cyclonic eddy shedding, which would remain trapped between A_1 and the African coast. Water parcels of the leftwards side of the stream (looking downstream) should be caught during the instability. After the eddy shedding, the AC would enter the eastern basin following a more eastward direction. Less AW is arriving at the eastern basin during the growth of A_1 and, probably, the size of A_2 would be reduced if part of the AW inside it is drained to feed the Algerian Current. All this would lead to situation 3-c from 3-a. In the frame of this highly simplified dynamics, the ICTIOALBORAN-93 survey would have been carried out shortly after the hypothetical shedding, as the water of its core is still distinguishable from the surrounding waters.

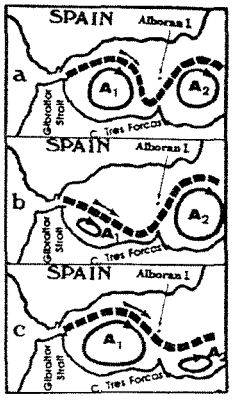


Fig. 3.Three possible situations of the gyres current system in the Alboran sea.

REFERENCES
CANO N. and CASTILLEJO, F., 1972. Contribucion al conocimiento del Mar de Alboran: variaciones del remolino anticiclonico. *Bol. Inst. Esp. Oceanogr.*, 157 : 3-21.
HEBURN, G.W., LA VIOLETTE,P., 1990. Variations in the structure of the anticyclonic gyres found in the Alboran Sea. *J. Geophys. Res.*, 95 : 1599-1613.
PRELLER R., 1986. A numerical model study of the Alboran Sea gyre. *Prog. Oceanogr.*, 16 : 113-146.
WHITEHEAD J.A., MILLER A.R., 1979. Laboratory simulation of the gyre in the Alboran Sea. *J. Geophys. Res.*, 84 : 3733-3742.

ON THE REVERSAL OF THE SURFACE CIRCULATION ON THE CATALAN CONTINENTAL SHELF

GARCÌA M. A., ROJAS P., SOSPEDRA J., FIGA J. PUIGDEFÀBREGAS J. and S.-ARCILLA A.

Laboratori d'Enginyeria Maritima.Universitat Politècnica de Catalunya c/Gran Capità s/n, mod. D1. 08034 Barcelona, Spain

The hypothesis that the general southwestward circulation on the Catalan continental shelf may reverse seasonally or rather for periods longer than the typical duration of mesoscale events has been suggested by different authors. We propose that at least two different mechanisms may cause such inversions in the current direction. The first of them is of a barotropic nature and shows as a long period wave in the low-pass filtered time series of current data obtained at the CASABLANCA oil rig and analyzed extensively by FONT *et al.* (1990). Related to this, PEPIO and PELLISE (not published) processed a two-year record of mean sea level data acquired at Cala Justell, Vandellos, just a few kilometers apart from the oil rig and found that there was significant spectral energy at the 20-day period band.

The second mechanism, which is of a baroclinc character, is the inversion of the density front on the Catalan continental slope. MASO and TINTORE (1991) and SABATES and MASO (1992) concluded on the basis of dynamic computations with a reference level of 100 dbar that the presence of light water on the slope induced a circulation to the northeast on the Catalan shelf during May/June 1983.

During the MECA 93 experiment conducted in the Blanes Canyon area, R/V Hespérides occupied a grid of 54 CTD stations between 17th and 22nd June, 1993. The characteristic spacing between adjacent stations was 5 to 7 nm. ADCP measurements were obtained both along-track and at the sampling stations. Five LCD drifters were launched at selected positions on the northeasternmost section of the cruise and were further tracked via Argos for a period of about two months. Contemporary NOAA/AVHRR and ERS-1/SAR imagery covering the study area and neighbouring zones were processed off-line.

ADCP measurements show that the currents on the shelf were to the northeast above the pycnocline and southwestward at deeper layers (figure 1). The salinity distribution indicates the presence of light water bodies on the continental slope. The agreement between the dynamic height distribution computed with reference to the pycnocline level and the surface current field derived from the ADCP measurements suggests that the dynamics of the mixed layer was essentially geostrophic (see figure 2). It should be noted that the wind conditions were extremely mild during the cruise. The analyzed AVHRR images evidence that the inversion of the density front, linked to the southwestard advection of water from the Gulf of Lions, probably affected a large stretch of the Catalan shelf. This is coherent with the northeastward trajectory of the LCD buoys between Barcelona and Blanes whenever they drifted on the shelf.

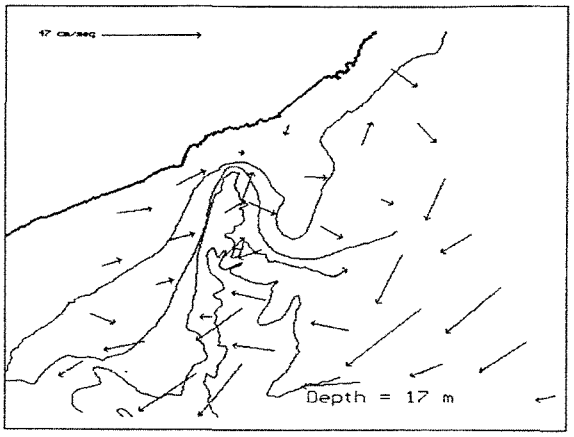


Figure 1. MECA 93 experiment. ADCP velocities at 17 m depth.

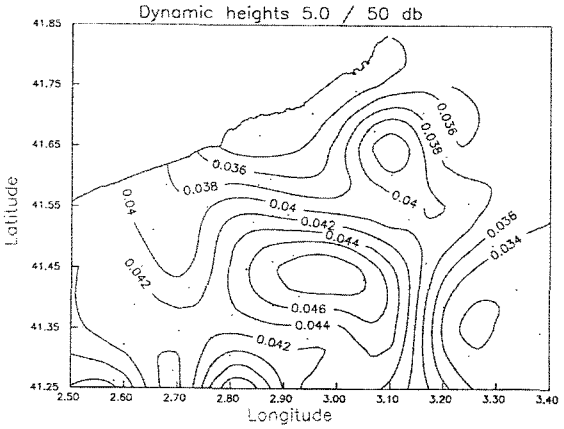


Fig. 2. MECA 93 experiment. Dynamic heights at 5 dbar computed with a 50 dbar reference level.

REFERENCES

FONT J., SALA, J. and JULIA A., 1990. Marine circulation along the Ebro continental margin. *Marine Geology*, 95: 165-177.

MASO M. and TINTORE J., 1991. Variability of the shelf water off the northeast Spanish coast. *Journal of Marine Systems*, 1: 441-450.

PEPIO S. and PELLISE M.M, not published. Analisis de registros de marea en Vandellos.

SABATES A. and MASO M., 1992. Unusual larval fish distribution pattern in a coastal zone of the western Mediterrancan. *Limnology and Oceanography*, 37(6): 1252-1260.

ÉTUDE DE LA CIRCULATION MÉSOÉCHELLE POST CONVECTION DANS LA ZONE MEDOC

J.-C. GASCARD[1], S. GANA[1,2], C. RICHEZ[1] et C. ROUAULT[1]

[1] LODYC, Univ. Pierre et Marie Curie, 4 place Jussieu, 75252 Paris Cedex 05 France
[2] INSTOP, Salammbô, 2025 Tunisie

Au cours de l'hiver-printemps 91-92, nous avons pu observer la circulation de mésoéchelle dans la zone Medoc pendant la période post convection (2 mars au 10 avril 92) grâce à l'utilisation de flotteurs lagrangiens dérivant respectivement à 300, 1000 et 1200 m de profondeur. Des relevés hydrologiques effectués pendant les expériences CONVHIV et THETIS, avant et après la mise en oeuvre des flotteurs, nous permettent de reconstituer les conditions de stratification avant, pendant et après la convection hivernale. Ces relevés indiquent notamment qu'une phase active de convection s'est déroulée en février 92 et que la profondeur maximum de convection a atteint 1600 m (Open-Ocean Deep Convection Explored in the Mediterranean, Thetis group EOS, Vol. 75, n°19, May 10, 1994). Les relevés hydrologiques précédant cette phase convective, permettent, dès le mois de Janvier 92, de délimiter la zone où la convection va se développer, 1 mois plus tard.

Les trajectoires des flotteurs révèlent une dynamique de mésoéchelle très active principalement dans la gamme 8-10 jours et 25-30 km. Les flotteurs évoluent au dessus de profondeurs allant de 1750 à 2370 m. Leurs vitesses tangentielles varient de 0 à 20 cm/s environ. Les mouvements présentent une forte composante barotrope entre 300 et 1000 m. Les différences de hauteurs dynamiques calculées à partir des réseaux hydrologiques sont très faibles et par conséquent la composante barocline est faible également. Comme nous l'indiquent les flotteurs, le cisaillement vertical des vitesses horizontales est faible aussi. Pour le flotteur à 300 m, les variations de vitesse suivent en phase les variations de profondeur d'eau de manière remarquable. La cohérence des mouvements aux 3 niveaux est, elle aussi, remarquable (figure 1), bien que les 3 flotteurs suivent des trajectoires très différentes. De façon surprenante, le flotteur le plus profond est animé des vitesses les plus grandes. Après 50 jours en plongée les 3 flotteurs sont relocalisés à des endroits très proches les uns des autres et non loin des positions de départ.

Les enregistrements de température, pression et vitesse verticale au niveau de chaque flotteur, indiquent que la période de convection active s'est achevée juste avant la mise en oeuvre des flotteurs. Le flotteur à 300 m révèle le retour de l'eau intermédiaire vers la mi-mars dans la zone de convection (figure 2), retour signalé par une élévation rapide de la température de 0.3°C. Ce retour à la stratification apparait aussi très clairement (point de rebroussement) et simultanément (vers le 16 mars 1992) sur les trajectoires des 3 flotteurs, 1 mois après le début de la phase active de convection qui n'a duré que 15 jours environ en 1992. Les relevés hydrologiques effectués en avril montrent aussi que le retour de l'eau intermédiaire a eu lieu et donc, avec elle, le retour de la stratification dans la région.

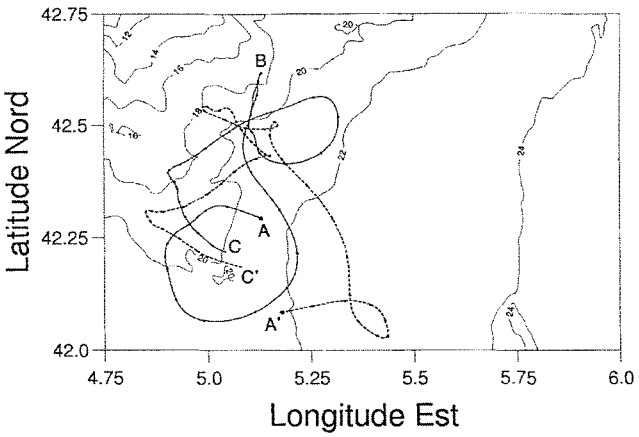


Figure 1 : Trajectoires de 2 flotteurs à 300 m (trait plein) et à 1000 m (trait pointillé) de profondeur du 2 mars 92 (A), au 16 mars 92 (B), au 10 avril 92 (C).

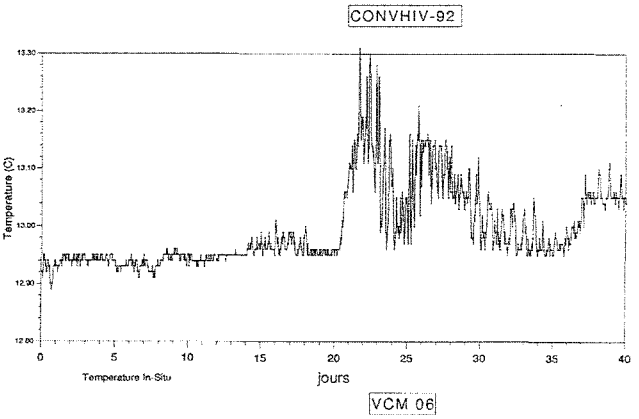


Figure 2 : Température *in situ* du flotteur à 300 m de profondeur du 2 mars 92 au 10 avril 92

A SYSTEM OF THREE INTERACTING EDDIES IN THE ALGERIAN BASIN, SPRING 1993, AS SEEN BY AVHRR AND TOPEX/POSEIDON ALTIMETER DATA

P. GEROSA[1], D. IUDICONE[1], S. MARULLO[2], R. SANTOLERI[3]

[1] Gruppo Oceano, Dip. di Fisica, Univ. "La Sapienza", Piaz. Moro 2, 00185 Roma, Italy
[2] ENEA Centro Ricerche "La Casaccia", Via Anguillarese 301, 00060 Roma, Italy
[3] Istituto di Fisica dell'Atmosfera, CNR, Piazzale L. Sturzo 31, 00144 Roma, Italy

A very clear AVHRR image of April 19 1993, GMT 03:13, shows a very complex structure in the Algerian Basin, West Mediterranean Sea in an area between 6.5°E-8.5°E of longitude and 37.2°N-38.5°N of latitude. This area is delimited at South by the African coast and at East by the rising of bottom topography in the Sardinian channel.

This structure (see figure), strictly connected with the eastern flowing of the Algerian Current, constituted by MAW (Mediterranean Atlantic Water) incoming from the Strait of Gibraltar, has the shape of three highly convoluted spiral eddies, two of them zonally aligned (A and B, respectively centered in 38.0°E 7.0°N and 38.1°E 7.9°N) and the third one (C, centered in 37.5°E 8.1°N) South-East of the first two. The eddies have an almost uniform SST of 14.7°C with some cold patches of probably entrained water.

Their spiraling shapes suggest a cyclonic circulation for the North-Western (A) and the southern (C) ones and an anti-cyclonic for N-E one (B), as two coupled mushrooms sharing the middle eddy (B). They have a mean radius of about 30 km but A and, above all, C are elliptical.

In addiction to the preceeding analysis, one year of high quality TOPEX/Poseidon altimeter data of the West Mediterranean Sea have been processed with up-to-date algorithms using the repeated-tracks method (the repetition cycle for the tracks is about ten days) in order to extract the variable sea level topography. Many problems have been met as always happens when working with altimetric data in the Med. Sea (short tracks, tide corrections not well established, near coastal sampling not accurate, oceanic signal to noise amplitude ratio too low). Moreover this very recent satellite has orbits too spaced (about 100 km) with respect to the oceanographic typical length scales (in Med. Sea Rossby radius is of order of ten km).

In spite of these difficulties it was possible to observe a strong oceanic anomaly in the same area and in the same period of the AVHRR image. In particular one track (track number 146, passage number 22 and 23 of the same period ov AVHRR image) shows a good correlation with SST data, allowing to confirm the suggested circulation for eddies B and C.

Successive cycles of the TOPEX/Poseidon altimeter clearly show that the structure B moves towards North-West with a speed of about 3 km for day.

An attempt to explain this complex feature (see for instance FEDOROV and GINSBURG, 1986; HOPFINGER and VAN HEIJST, 1993 and VAN HEIJST, KLOOSTERZIEL and WILLIAMS, 1991) is possible in term of vorticity balance taking into account the Algerian current instabilities, the well established presence in the area of large barotropic anti-cyclonic eddies and interaction with bottom topography (see for instance MILLOT, 1991).

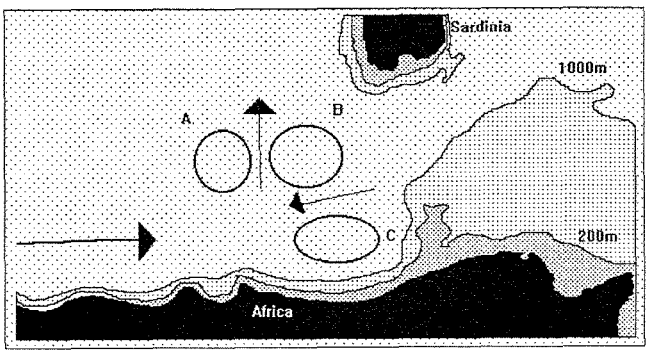


Figure : A schematic diagram of the phenomena

REFERENCES

FEDOROV K. N., and GINSBURG A. I., 1986. Mushroom-like currents (vortex dipoles) in the ocean and a laboratory. *Ann. Geophys.*(B,5) : 507-513.

HOPFINGER E. J. and VAN HEIJST G. J. F., 1993. Vortices in rotating fluids. *Annu. Rev. Fluid Mech.*, 25 : 241-289.

MILLOT C., 1991. Mesoscale and seasonal variabilities of the circulation in the western Mediterranean. *Dyn. of Atm. and Oceans*, 15 : 179-214.

VAN HEIJST G. J. F., C.W. M. KLOOSTERZIEL, 1991. Laboratory experiments on the tripolar vortex in a rotating fluid. *J. Fluid Mech.*, 225 : 301-331.

FINITE ELEMENT MODELLING OF THE TIDE-CURRENT INTERACTIONS IN THE STRAIT OF GIBRALTAR

GONZALEZ M., GARCÌA M.A., ESPINO M. and S.-ARCILLA A.

Laboratori d'Enginyeria Maritima Universitat Politècnica de Catalunya c/Gran Capità s/n, mod. D1 08034 Barcelona, Spain

The tidal wave propagation patterns and tide-current interactions in the Gibraltar Strait are examined by means of a quasi-3D finite element model of the shallow water equations (GONZALEZ, 1994). The spectral decomposition of the time-dependent variables allows the transformation of the transient problem into a number of simpler steady-state problems - one per each of the considered harmonic frequencies (see e.g. WALTERS, 1986). As per the residual flow, a 3D numerical approximation has been worked out making use of the ECADIS code developed by ESPINO (1994).

The numerical solutions are in quite good agreement with local observations reported by RICO and RUIZ (1988) and others. The M2 tide is seen to have eastward-decaying amplitude and to propagate southwards at the Mediterranean side of the Strait, just as expected. The solutions for the S2 and N2 tidal waves exhibit a similar character. On the contrary, the K1 co-range lines are parallel to the axis of the Strait, whereas the co-phase diagram indicates that the propagation of this wave is to the east (figure 1).

Figure 2 shows the vertical profiles of the M2 current velocity and phase obtained at a mooring site occupied during the Gibraltar Experiment 1986/87. It can be observed that the inclusion of realistic, vertically-varying density and residual flow distributions is crucial to reproduce the structure of the measured tidal circulation, whose major axis and phase decrease with depth.

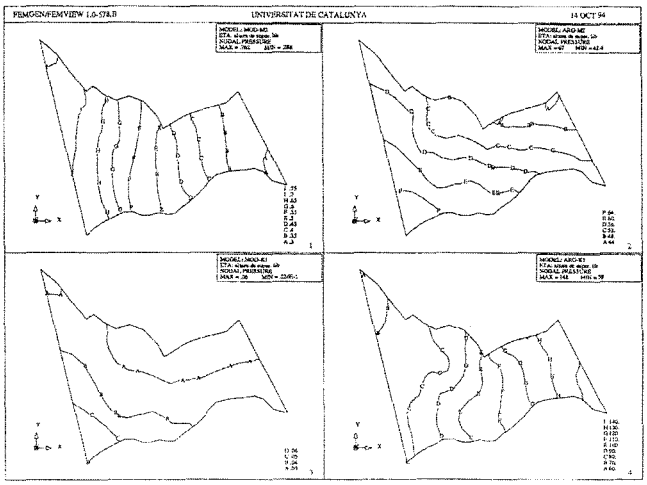


Figure 1. Numerical solutions for the M2 and K1 tides. Upper left: M2 amplitude. Upper right: M2 phase. Lower left: K1 amplitude. Lower right: K1 phase.

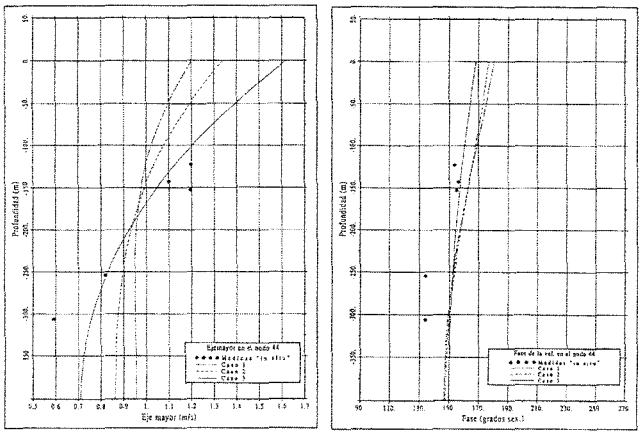


Figure 2. M2 current. Numerical solutions for the major axis (left) and phase (right) with 2 d.o.f. versus measured values on Camarinal Sill.
Case 1: only with bottom friction. Case 2: with friction and vertically-varying density. Case 3: with friction and vertically-varying density and residual flow.

REFERENCES

ESPINO M., 1994. Estabilizacion de la Superficie Libre en la Solucion de Ecuaciones Shallow-Water por Elementos Finitos. Aplicaciones Oceanograficas. PhD Thesis, Universitat Politècnica de Catalunya.

GONZALEZ M., 1994. Un modelo numérico en elementos finitos para la corriente inducida por la marea. Aplicaciones al Estrecho de Gibraltar. MSc Thesis, Universitat Politècnica de Catalunya.

RICO J. and RUIZ A., 1988. Fluctuaciones del flujo en el Estrecho de Gibraltar. Seminario sobre la Oceanografia Fisica del Estrecho de Gibraltar, ed. J.L. Almazan *et al.*, SECEG.

WALTERS R.A., 1986. A Finite Element Model for Tidal and Residual Circulation. Communications in *Applied Numerical Methods*, 4 : 401-411.

HIGH AND LOW FREQUENCY COMPONENTS OF CURRENT IN WESTERN MEDITERRANEAN SEA FROM ACOUSTIC DOPPLER CURRENT PROFILER (ADCP) AND HYDROGRAPHIC DATA

Elisa G. GORRIZ[1] and Julio CANDELA[2]

[1] Institut de Ciències del Mar, Barcelon, Spain
[2] Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, USA

In the Western Mediterranean, where mean currents are usually weak, important high frequency velocity fluctuations, corresponding mainly to inertial oscillations, have been recorded with eulerian currentmeters in surface and intermediate waters. This poses a major problem in mesoscale dynamics studies from ship underway current measurements, since spatial and temporal variability are mixed.

A filtering method (CANDELA *et al.*, 1992) has been applied to separate high and low frequency observations of currents recorded with a vessel mounted Acoustic Doppler Current Profiler (ADCP) in several cruises in the Catalan and Alboran seas during Spring-Autumn 1992. Such filtering regards the current data as function of time and location, integrating also hydrographic data to consider the vertical and horizontal effect of thermohaline fronts in the coherence of near-inertial motion. The low frequency currents obtained with this method are compared with geostrophic velocities from CTD, discussing the ranges of error affecting data from different sources.

In the Alboran Sea, where the dynamics is greatly determined by the exchange of Atlantic and Mediterranean water through the Strait of Gibraltar, the currents of low frequency show the western Alboran gyre, also detected with geostrophic studies and satellite images (SHIRASAGO *et al.*, 1994). Tidal currents play a significant role in the area (CANDELA and LOZANO, 1994). They have been separated by the filtering method, accordingly to main tidal frequencies. A discussion on mesoscale structures observed from the separated frequency components is made.

This study is part of EUROMODEL MAST II/MTP project (MAS2-CT93-0066). E.G. Gorriz acknowledges a research grant from the Comissio Interdepartamental de Ciència i Tecnologia, Generalitat de Catalunya.

REFERENCES

CANDELA J., LOZANO J., 1994. Barotropic response of the Western Mediterranean to observed atmospheric pressure forcing. *In* : The seasonal and interannual variability of the Western Mediterranean Sea. Ed. P.E. La Violette, American Geophysical Union, *Coastal and Estuarine Studies*, 46 : 325-360.

CANDELA J., BEARDSLEY R.C., LIMEBURNER R., 1992. Separation of tidal and subtidal currents in ship-mounted Acoustic Doppler Current Profiler observations. *J. Geophys. Res.*, 97 : 769-788.

SHIRASAGO B., GORRIZ E.G., FONT J., 1994. Comparison between ERS-1 SAR images and acoustic Doppler current profiler (ADCP) velocity data in the Alboran Sea. *In* : Proceedings of the European Symposium on Satellite Remote Sensing, Roma (in press).

EVAPORATION PROBLEM AND LONG TERM VARIABILITY IN THE COASTAL AREA

Branka GRBEC and Gordana BEG PAKLAR

Institute of Oceanography and Fisheries, Split, Croatia

Evaporation is a physical process that takes place at the boundary surface between water and the air above it. Evaporation heigh is usually given in the form :

$$h_e = f_1(p)\, x\, f_2(T)\, x\, f_3\, x\, (e_s - e_w)$$

where each term represents the effect of one of the meteorological elements (p the pressure, T the absolute temperature, u the wind speed); e_s is the maximum vapour pressure corresponding to temperature and salinity of water, ea is the vapour pressure in the air. Different expressions have been chosen for the functions f_1, f_2 and f_3 and a formula of this type results in the well know formulas for empirical evaporations (JAKOBS, 1958; LAEVASTU, 1965; GILL, 1982) showing the dependence of prevailing weather conditions.

Data used for this work were collected from meteorological stations at three location along Adriatic coast (Trieste, northern Adriatic; Split midlle Adriatic and Dubrovnik, southern Adriatic). Based on the mean monthly values, evaporation was calculated first for the station Trieste for the period 1961-1970 using three different bulk aerodynamic formulas (JAKOBS, 1958; LAEVASTU, 1965; GILL, 1982). As e_w and e_a are not linear function of the meteorological parameters, a difference of more than 15% between the results obtained averaging daily evaporation data and ones obtained computing ew and ea by direct used of monthly mean data are evident (PICCO, 1991). Besides using the same data set different empirical constant K appear in formula for evaporations (PICCO, 1991; STRAVISI and CRISCIANI, 1986; SUPIC, 1993). Values found from preceding formula were also different from evaporation obtained by thermal equlibrium equations (ZORE-ARMANDA, 1968). Figure 1 show results of three different formula.

The influence of each meteo-oceanographic parameters in each formula was checked and results were compared with the evaporation data over land (station Trieste). Finaly, the most suitable formula was chosen and used to calculate long-term fluctuations and linear trend along the Adriatic coast.

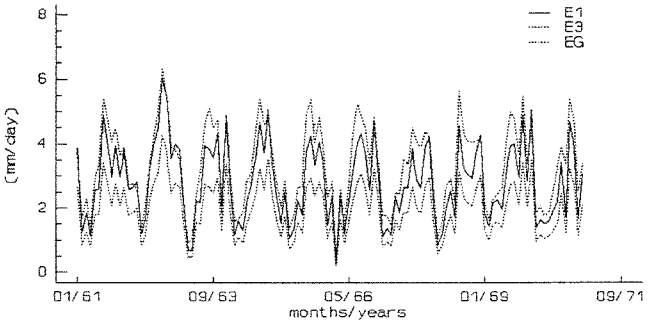


Figure 1. Mean monthly evaporations (mm/day) calculated using three different formula for station Trieste, period 1961-1970. Time series denoted as E1 is calculated using Jacobs formula, E3 using Laevastu and EG using Gills formula.

REFERENCES

GILL A.E.,1982. Atmosphere Ocean Dynamics. Academic Press, New York, N.Y., p. 662

JAKOBSW.C.,1958. On the energy exchange between sea and atmosphere. *J. Mar. Res.* 5 : 37-66

LAEVASTU T., 1960. Factors affecting the temperature of the surface layer of the sea, Merentutkimuslait. Julk. 195, Helsinki.

PICCO P., 1991. Evaporation and Heat Exchanges between the Sea and the Atmosphere in the Gulf of Trieste during 1988. Il Nuovo Cimento, Vol. 14 C, N.4 Luglio-Agosto.

STRAVISI F. and CRISCIANI F., 1986. Estimation of surface heat and buoyancy fluxes in the Gulf of Trieste by mean of bulk formulas. *Boll. Ocean. Teor. Appl.* , IV, I, 55.

SUPIC, N., 1993. Surface Fluxes and Hydrographic characteristics of the Northern adriatic, Sveuciliste u Zagrebu.

ZORE-ARMANDA M., 1968. Evaporation from the Adriatic Sea. Hidrografski godisnjak.

O

A WESTERN MEDITERRANEAN SEA GENERAL CIRCULATION MODEL

C. HERBAUT[1], L. MORTIER[2], F. MARTEL[2] and M. CRÉPON[1]
[1] LODYC BC 100, UPMC, 4 place Jussieu 75005 PARIS, France
[2] CETIIS, Ivry/Seine, France

A high resolution general circulation model of the Mediterranean Sea was forced during 20 years by imposing daily atmospheric forcing and transports through the straits. The daily atmospheric forcing is provided by the analyzed outputs of the Météo-France Arpége operational model and the transports through the straits are driven by the density gradients between the Mediterranean sea and the Atlantic ocean (strait of Gibraltar) and the Eastern Mediterranean Sea (strait of Sicily). The grid mesh is 10km*10km and 31 levels are used on the vertical. The turbulence is parametrized by a second order closure scheme based on the mixing length as defined in BLANKE and DELECLUSE (1993).

After 20 years the model is in equilibrium. Energy is quite steady. The Levantine Intermediate Water has progressed from the Sicily strait until the Gibraltar strait following the West coast of Sardinia and the northern coast of the Western basin. Deep water formation is occurring every winter at the end of February. During summer, a realistic re stratification is observed. The transport through the Gibraltar strait is maximum during the January-June period where it reaches a value of 1.3 Sv. up to 1.5 Sv and minimum between July-October with 1.1 Sv.

A large anticyclonic eddy forms in the western basin of the Alboran Sea. The surface current is very unstable in the eastern Alboran Sea and along the Algerian coast where strong velocities are observed (up to 40 cm/s). At the level of the Sicily Strait, the current splits into two branches : one enters the strait while the other one continues along the Italian coast. The latter crosses the Corsican Channel and forms the Northern Current. The surface circulation is qualitatively consistent with the pattern described in MILLOT (1987 b). Meanwhile the Levantine Intermediate Water (LIW) exits the Strait of Sicily, turns eastward along the Italian coast and flows cyclonically around the Tyrrhenian Sea. Outflowing south of Sardinia, the LIW current follows the western coast of that island and progresses towards the northern basin. It then flows westward, trapped along the Italian and French coasts. Velocities in the current are typically 4 to 5 cm/s.

The most surprising result of the simulation is the importance of the barotropic circulation. The Northern Current barotropic transport is about 1 Sv, comparable to the observed transport that varies between 1.5 and 2.2 Sv. The barotropic transport amounts 2 Sv in the Tyrrhenian Sea, while it reaches about 10 Sv in the Alboran Sea gyre.

The transports through the different straits show strong annual variability which is investigated in terms of atmospheric forcing.

DESCRIPTION OF THE ADRIATIC OUTFLOW CURRENT AS OBSERVED FROM THE ELNA DATA

Tom Sawyer HOPKINS[1], Antonio ARTEGIANI[2] and Massimo DE LAURO[3]
[1] MEAS/NCSU Raleigh, NC, USA
[2] CNR/IRPEM, Ancona, Italy
[3] CNR/GEOMAR, Naples, Italy

The primary export of Northern Adriatic surface waters is shown to be restricted to a well-defined outflow on the western side, the Adriatic Outflow Current (AOC). This is a small-scale version of an equatorward, continental-shelf boundary current that is stable with respect to planetary vorticity, like for example, the Mid-Atlantic Bight Shelf Current or the East Greenland Current. The Po runoff and effluents from smaller rivers distributed along the Italian coast comprise the sources of fresh water that sustain a less-dense, shelf water mass. This coastal input of buoyancy generates an isostatic sea-level rise towards the coast that geostrophically drives the barotropic boundary current. The bottom flow generates an offshore frictional transport, that causes a prograde tilt to the pycnocline and an opposing baroclinic shear with depth (i.e. a downwelling circulation). The AOC can be strongly influenced by local winds (cf. ORLIC *et al.*, 1992). The orographic definition of the land boundaries tends to orient winds along the axis of the basin. Most importantly, the wind-driven effect of the Sirocco, from the southeast, counterpoises the AOC and can, with sufficient strength, set up a temporary upwelling circulation. Winds from the northwest accelerate the AOC circulation; and Bora winds, from the northeast, create a similar but more complicated response (Ekman and barotropic flows in opposition at the surface). The low-frequency consequence, of the AOC transporting water out from the northern terminus of the Adriatic, is a compensating inflow and a cyclonic tendency to the mean circulation of the Northern Adriatic.

A primary objective of the ELNA (Eutrophic Limits of the Northern Adriatic) Project is to establish seasonal budget for carbon-related parameters in the Northern Adriatic. Fundamental to this objective is a quantification of the transport and associated mass fluxes exiting the Northern Adriatic by means of the AOC. This work presents preliminary assessments of these transports from the seven ELNA cruises, and selected values from the monthly sections (from Feb' 93 to Dec' 94) of Senigallia and Cesenatico, using the steric-height method (HOPKINS, 1994). The treatment allows for a reasonably clear depiction of the seasonal, along-stream, and lateral structure of the AOC under different runoff and wind forcing conditions. Several examples of mass-flux calculations are given of the CTD-derived variables, such as freshwater and chlorophyll. The freshwater flux is matched with the estimates of runoff to ascertain the uniqueness of the AOC as the surface export mechanism for the Northern Adriatic. Preliminary conclusions, concerning the implications of the observed AOC variability to the Northern Adriatic ecosystem, are also presented.

REFERENCES

HOPKINS, T. S., 1994. A note on the dynamic method referenced to a point. Submitted to *Continental Shelf Research*.

ORLIC M., KUZMIC and Z. PASARIC, 1994. Response of the Adriatic Sea to the bora and sirocco forcing. *Continental Shelf Research*. Vol. 14 (1) : 91-116.

PRELIMINARY RESULTS FROM A SUB-PYCNOCLINAL BOX MODEL OF THE ELNA OXYGEN DATA

Tom Sawyer HOPKINS[1], Viva BANZON[1] and Antonio ARTEGIANI[2]

[1] MEAS/NCSU, Raleigh, NC, USA
[2] CNR/IRPEM, Ancona, Italy

The annual cycle of dissolved oxygen below the pycnocline is dominated alternately by different physical and biological processes. Despite this complicated forcing, the resultant behavior of the dissolved oxygen concentration is a fairly well-behaved, time dependent function and is easily observable. HOPKINS and DELLAPORTA (1989) demonstrated how an empirical model could be used to forecast hypoxia in the Northern Adriatic.

In the present work, the authors use recently observed data (ELNA Project) to provide a validation test of the model. The box model is also used as a point of discussion of the relative importance of the various processes affecting the concentration of oxygen in the Northern Adriatic.

The Northern Adriatic is divided into eight compartments on the basis of its mean circulation and water-mass structure. Each compartment is ascribed characteristic values for: benthic and lower-layer oxygen consumption rates; seasonal variations in the depth of the pycnocline; sub- pycnoclinal photosynthesis; and an advection source term. The estimates of the benthic respiration are taken from the box-core incubation studies performed during the various ELNA cruises and from the results of other recent studies. Photosynthetic production below the pycnocline is also estimated from rates observed during the ELNA cruises. The advective source term is taken from the observed circulations and oxygen concentrations. In some cases, the estimates were taken from the historical data summaries compiled by ARTEGIANI and RUSSO (1994).

The results demonstrate the susceptibility of the western and northern areas to hypoxia. The bottom waters of these areas are obviously exposed to greater surface loading. For the period of late spring through early summer, the rate of oxygen decrease is controlled by bio/chemical respiration processes. The advective contribution is negligible until the horizontal differences in the *in situ* respiration have created significant oxygen gradients. By mid-summer, advective replenishment decreases due to a more sluggish circulation. Perhaps more significant is that oxygen preferentially decreases in the western areas that are downstream and offshore of the Po Plume. In late summer, re-supply occurs primarily through the deepening of the wind-mixed layer. This empirical modelling approach, when combined with selective monitoring, provides a valuable forecast capability for areas threatened by hypoxia/anoxia events.

REFERENCES

HOPKINS T. S. and FRANCO DELLAPORTA 1990. A box model of the sub- pycnoclinal oxygen in the Northern Adriatic. Presented at the Marine Coastal Eutrophication Conference, Bologna, 20-21 March 1990.

ARTEGIANI A. and A. RUSSO 1994. Seasonal water-mass structure in the Adriatic Sea, compiled from available historical data. Unpublished document.

RECENT CHANGES IN THE BLACK SEA PYCNOCLINE

L. I. IVANOV[1], S. BESIKTEPE[2], E. OZSOY[2], M. DUMAN[3], V. DIACONU[4] and E. DEMIROV[5]

[1] Ukrainian Academy of Sciences, Marine Hydrophysicla Institute, 2, Kapitanskaya Str., Sevastopol 33500 Crimea, Ukraine
[2] Institute of Marine Sciences, Middle East Technical University, P.K. 28, Erdemli, Içel 33731 Turkey
[3] Institute of Marine Sciences and Technology, Dokuz Eylül University, 1884/8 Sokak, 10 Inciralti, Izmir, 35340 Turkey
[4] Romanian Marine Research Institute, 300 Mamaia bd, Constantza 8700, Romania
[5] Inst. of Oceanography, Bulgarian Academy of Science, POB 152, Varna 9000, Bulgaria

Possible changes in the Black sea pycnocline has been investigated by many authors (BLATOV *et al.*, 1984; CODISPOTI *et al.*, 1991, MAMAEV *et al.*, 1994; MURRAY *et al.*, 1991; BUESSELER *et al.*, 1994). Recent CDT measurements (basin-wide and partial surveys within the context of the CoMSBlack program and TU-Black Sea Project) in the Black sea provide a unique opportunity to study pycnocline structure and to understand the role of different mechanisms in its ventilation.

Direct ventilation appears to be confined above the mean position of the pycnocline (σ_t = 14,5 - 14,7) where convection and subsequent isopycnal injection is thought to be the major water mass formation mechanism (BLATOV *et al.*, 1984; MURRAY *et al.*., 1991; OVCHINNIKOV, 1981). Some ventilation of the upper pycnocline (down to σ_t = 15,6) appears to occur in winter in the central parts of the sea (IVANOV *et al.*,1994). Similarly, ventilation of the lower pycnocline can occur by entrainment of the Cold Intermediate Water (CIW) into the Mediterranean water near the Bosphorus and the subsequent injection below the pycnocline (σ_t = 15,8 - 16,2) intrusions of the resulting shelf modified waters (BUESSELER *et al.*, 1991).

The position of selected σ_t surfaces and the corresponding values of temperature are presented in the following for recent surveys. Both values are basin averaged quantities, filtering effects of local dynamics.

σ_t	average depth (m)				average temperature (°C)			
	1991	1992	1993	1994	1991	1992	1993	1994
14,8	65,6	70,4	72,1	74,7	7,30	6,94	6,33	6,58
15,0	71,0	76,5	80,5	81,4	7,50	7,20	—	—
15,2	77,0	82,1	86,5	87,7	7,66	7,53	7,31	7,18
15,4	84,0	88,8	92,8	94,2	7,81	7,76	7,62	7,47
15,6	92,5	96,9	100,2	101,8	7,96	7,95	7,88	7,74
15,8	102,5	107,0	109,0	111,4	8,13	8,10	8,08	7,98
16,0	115,9	119,8	121,6	124,8	8,30	8,27	8,25	8,19
16,2	135,1	138,2	139,3	143,3	8,46	8,43	8,42	8,38

The table shows considerable interannual variability in the thermohaline structure of the pycnocline. Gradual deepening of the isopycnal interfaces since 1991, together with cooling and freshening, has been registrated. Meteorological data reveal a decrease in the average winter air temperature for the region in 1991-1993. Although the winter of 1994 was warmer, the cooling in the lower part of the pycnocline appears to have continued during this period as a delayed response to the earlier surface cooling.

The cooling between σ_t = 15,2 -16,2 surfaces is partly due to Bosporous influence, evident from the isopycnal temperature distribution in the vincinity of the Strait. In 1994, when the most dramatic changes were observed, the mean temperature in the central part of the sea was higher than for the whole area. It is estimated that lateral advection along isopycnals from the near Bosphorus region resulted in 0,03°C temperature decrease for the lowerpart of the pycnocline. This allows to estimate the volume of laterally injected water in 1993-1994 to be about 2500km^3. More than 50% of temperature decrease is estimated as due to vertical mixing.

REFERENCES

BLATOV A. S., BULGAKOV N.P., IVANOV V. A., KOSAREV A. N., TUZHILIN V. S., 1984. Variability of hydrophysical fields in the Black sea. Hydrometeolzdar, 240 p.

BUESSELER K.O, LIVINGSTONE H . D., CASSO S. A., 1991. Mixing between oxic and anoxic waters of the Black sea as traced by Chernobyl cesium isotopes. *Deep-Sea Res.*, 38, suppl. 2 : 725-746.

BUESSELER K.O, LIVINGSTONE H . D., IVANOV L. I., ROMANOV A. S., 1994. Stability of the oxic/anoxiv interfaces in the Black sea. *Deep-Sea Res.*, 41 : 283-296.

CODISPOTI L. A., FRIEDERICH G. E., MURRAY J. W., SAKAMOTO C. M., 1991. Chemical variability in the Black sea : implication of continuous vertical profiles that penetrated the oxic/anoxic interfaces. *Deep-Sea Res.*, 38, suppl. 2A : 691-716.

IVANOV L. I., BESIKTEPE S., NICOLAENKO E. G., ÖZSOY E., DIACONU V., DEMIROV E., 1994. Volumetric fine structure of the Black sea cold intermediate layer. submitted to *Deep-Sea Res.*

MAMAEV O. I., ACKHIPKIN V. S., TUZHILKIN V. S., 1994. Analysis of the Black sea waters. *Okeanologia*, 34 : 178-192.

MURRAY J. M., TOP Z., ÖZSOY E., 1991. Hydrographic properties and ventilation of the Black sea. *Deep-Sea Res.*, 38, suppl. : 663-689.

OVCHINNIKOV I. M., 1984. To the question of cold intermediate layer formation in the Black sea. DAN. SSSR, 279, N4, 986-988.

THE MODEL AND NATURE RESULTS FOR PLUME FRONT OFF THE DARDANELLES

V. IVANOV[1], E. NIKOLAENKO[1], N. STASHCHUK[1], V. VLASENKO[1], O. USLU[2], H. BENLI[2]

[1] Marine Hydrophysical Institute, Capitanskaya Str. 2, Sevastopol, P.O. Box 335000, Crimea, Ukraine

[2] Institute of Marine Sciences and Technology, 1884/8 Sokak N°10, 35340 Inciralti-Izmir, Turkey

On the basis of nature data and high resolution two-dimensional thermohydrodynamic model the plume front off the Dardanelles is studied. The complete system of Reynolds hydrodynamic equations with nonlinear terms and the terms for turbulent exchange is used. The system is solved numerically using a special small-scale grid. The typical temperature and salinity distributions to the fall of the Marmara Sea and the Aegean Sea are adopted as the initial conditions. The real bottom relief is used. The water mass discharge through the Dardanelles is determined. At the first stage the solution is derived in the absence of wind and for the sea at rest.

The movement of the plume slows down with time. After 4 days the thermohaline front was about 28 km off the Dardanelles. The temperature and salinity gradients across the front were 1.0°C/km and 1.6 psu/km, respectively. Numerous observations showed that a position of plume front depends essentially on wind activity. Its location may be different in a short time. With south-westward winds blowing the locking effect is often observed. This situation was simulated at the second numerical experiment. The wind speed was 7 m/s, and such wind blowing for one day. After wind forcing the frontal interface was displaced to a distance of about 8-10 km near a mouth of strait.

Due to the Marmara Sea water discharge and opposite-oriented drift circulation (induced by south-westward wind) a complicated thermohaline structure of waters within the subsurface layers is being thereby generated. The front became sharp and the thermal and salinity gradients increased. Besides, in the area of interaction of differently-oriented flows the thermohaline intrusions formed.

During the next days following the cessation of wind forcing, the structure of the plume frontal zone was evolving. Notwithstanding the termination of the locking wind, the sharpness of the front did not alter. Residual effects of the wind forcing, in the form of a "two-cell" pattern of drift circulation, are readily visualized in the vertical transect of the horizontal current component. Because of the delay intrinsic to the system, currents directed towards one another in upper layer facilitate a collision of two different water masses. This results in the formation of a very narrow frontal interface, about 600-800 m in width, with large gradients in both the salinity field and the temperature field, with the layering of waters continueing. The latter fact is confirmed by the occurrence of separate lenses in the lower strata, having closed salinity/temperature isolines, however, at different ranges from the front.

The north-easterly wind blowing from the Dardanelles during one day with the speed 7 m/s was used in the third numerical experiment. Here, under the impact of a wind-induced drift current an increase of the frontal zone width and formation of an isolated lens in the salinity field (detached from the main front and transported by the residual drift current) is observed. Further evolution of the thermohaline fields within the frontal zone results in the formation of a new front 20-25 km away from the strait. Similar to the results of the previous numerical experiment, the thermohaline structure of waters in the subsurface layers incorporating a system of inversions and intrusions is very complex. Such phenomena were documented regularly *in situ*.

In general, the model shows detailed vertical and horizontal physical features of the Dardanelles front. A comparison of model results and data of nature observations shows their similarity.

AN INVERSE MODEL OF THE BLACK SEA VERTICAL MIXING PROCESSES AND THE MIXING PARAMETERIZATION

Sergei KOCHERGIN[1], Sükrü BESIKTEPE[2], Leonid M. IVANOV[1] and Emin ÖZSOY[2]

[1] Ukrainian Academy of Sciences, Marine Hydrophysicla Institute, 2, Kapitanskaya Str., Sevastopol 33500 Crimea, Ukraine

[2] Institute of Marine Sciences, Middle East Technical University, P.K. 28, Erdemli, Içel 33731 Turkey

An adjoint model is developed formulating the one dimensional vertical mixing problem in the interior of the Black Sea, coupled with a model of the plume of Mediterranean Water modified on the shelf. The model seeks to determine the interior vertical mixing coefficients and the entrainment functions from observed profiles of temperature and salinity and input functions of plume initial values.

A separate method based on the interior diffusion equations, without explicit inclusion of the plume is used to calculate mixing coefficients from salinity profiles. In addition, direct methods are used to simulate the observed temperature and salinity mean profiles in the Black Sea.

Because the parameterization of vertical mixing is a major problem in numerical modelling of the Black Sea circulation via General Circulation Models, the results are of importance. Various degrees of success in the different types of models and their deficiencies are discussed.

METHOD OF DATAFILTRATION FOR INVESTIGATION OF COASTALLY TRAPPED WAVES STRUCTURES

KOCHERGIN S. V and JANKOVSKY A. E

[1] Ukrainian Academy of Sciences, Marine Hydrophysicla Institute, 2, Kapitanskaya Str., Sevastopol 33500 Crimea, Ukraine

Results of local experiment in Crimea shelf zone is considered. Modal structure of coastally trapped waves is examined. For amplitude of modes the system of linear equations is solving. Quantity of modes is less than quantity of stations. New method of filtrating is used. It is based on plane rotation of our system, minimization of any quadratic functional and sorting of new equation by its informatable. Due to this procedure level of noise in initial system is decreased. *A priori* information about dispersion of mistakes and maximum of mode's amplitudes are used. This method gives a possibility to use all information in solving of this incorrect mathematical problem and may be useful for solving of similar problems, in which modal structure of oceanography fields are used.

ENERGETICS-STATISTICS OF THE MEDITERRANEAN GENERAL CIRCULATION

G. KORRES[1], N. PINARDI[2], A. LASCARATOS[1]

[1] University of Athens, Greece
[2] IMGA–CNR, Modena, Italy

Energetical (volume averaged kinetic energy and available potential energy equations) and statistical analysis (3D EOF analysis) is applied to the global Mediterranean MERMAIDS GCM in order to understand the energy interactions (conversion between kinetic and available potential energy), the role played by each driving mechanism separataly (wind, heat fluxes, dissipative terms) and to extract the simulated space and time scales of variability occuring in the Mediterranean general circulation. Two model experiments (integrations) have been analyzed. In the first experiment (central) the model is drived using realistic monthly forcing (wind – heat fluxes) for the period 1980–1988 (NMC 1000mb analysis). Heat fluxes are calculated interactively by the model due to a sophisticated parameterization scheme. In the second experiment the wind forcing is kept constant to its annual average and only the heat fluxes vary interannually. The results of the central experiment have shown that the interannual variability of the basin has an event–like character followed by transition periods where anticyclonic features are mostly excited in the southern sector of the basin. The shape of variability centers is mainly gyre–like. Two major events have been identified occuring during the winters of 1981 and 1986 which are characterized by strong wind (mainly) and heat forcing. The mixed layer undergoes seasonal variations while the interannual signal (1981 and 1986 anomalies) is strong at the depth of the thermocline. Finally we discuss some topics concering the "memory" of the dynamical system which have been proved through our model experiments to be on the seasonal time scale (winter ocean conditions control the following summer behaviour).

O

ON THE FORMATION OF LEVANTINE INTERMEDIATE WATERS

A. LASCARATOS[1] and J. MARSHALL[2]

[1] University of Athens, Dept. of Apllied Physics, 33 Ippocratous Str.,10680 Athens, Greece

[2] Massachussets Institute of Technology, EAPS, Bld. 54-1523, Cambridge, MA 02139, USA

A theory of LIW water formation has been developed and is being tested out by appropriate numerical experiments. It ascribes an important role to baroclinic eddies which form around the periphery of the formation site and flux in water and bouyancy from the side keeping the convection shallow. The eddies also carry the LIW away.

Previous open ocean convection studies (JONES and MARSHALL, 1993) have shown that the rim current at the periphery of the cooling patch, becomes unstable and baroclinic eddies develop. These eddies advect heat laterally towards the cooling region. Under continuous atmospheric cooling, a final steady state is reached in which the heat brought in by the eddies balances the heat lost to the atmosphere. At this stage convection is 'switched off' and the mixed layer stops from deepening. The time needed for this equilibrium to be reached is (VISBECK and MARSHALL, 1994) Tfinal=9*(r**2/B)**(1/3), where r is the radius of the cooling patch and B the bouyancy loss.

In areas of cyclonic circulation such as the Rhodes Gyre the typical preconditionned stratification can be thought of as a stratified layer of depth H and constant N overlying a homogeneous deep layer. The time needed for convection to break the stratification and penetrate the deep layer (thus producing deep waters) is Tbreak_through=(NH)**2/2B.

We argue that if Tbreak_through is longer than Tfinal then the eddies will take control of the convection process before the chimney penetrates deep. In such a case intermediate, not deep, waters will be produced.

In a series of numerical experiments we show that such a mechanism could be responsible for the production of intermediate waters (LIW) in the Rhodes Gyre area under normal climatological forcing. On the other hand we show that this equilibrium is quite sensitive and that under severe winter forcing Tbreak_through can be smaller than Tfinal, in which case deep waters are expected to be produced.

LIW FORMATION AND SPREADING : A 3–D NUMERICAL STUDY

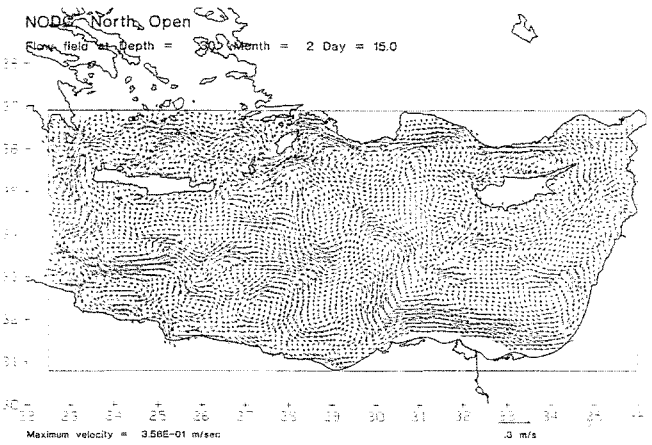
A. LASCARATOS, K. NITTIS and L. PERIVOLIOTIS

University of Athens, Department of Applied Physics, Lab. of Meteorology and Oceanography, Athens, Greece

The Levantine Intermediate Water (LIW) is the characteristic saline water mass of the Eastern Mediterranean that is formed in the Levantine sea. Various hypotheses have been introduced on the mechanism and the exact location of this formation, most of them indicating the Rhodes Cyclonic Gyre, in the northwestern Levantine, as the main formation site (OVCHINNIKOV, 1984; LASCARATOS *et al.*, 1993). During the spreading phase this water mass occupies the intermediate layers (typically 300 m) of the whole Mediterranean sea and exits through the straits of Gibraltar with modified, due to mixing, characteristics. It can be also found isolated at deeper layers, trapped by the energetic eddy field of the Eastern Mediterranean (THEOCHARIS *et al.*, 1993).

We use POM, a sigma coordinates, free surface, 3–D primitive equation model (BLUMBERG & MELLOR, 1987) to study the LIW formation and spreading in the Levantine sea. The model contains an imbedded second moment turbulence closure sub–model to provide vertical mixing coefficients. The area (east of 22.5E) is covered by a 220 x 120 high resolution (5–6 km) eddy resolving grid (first baroclinic Rossby Radius ~13 km). In the vertical 30 sigma–coordinate levels with logarithmic distribution near the surface are used. Open boundary conditions are used for the communication with the Ionian (to the West) and the Aegean sea (to the North).

The model will be initialized with POEM hydrological data and forced by heat and water fluxes computed from the model's SST and atmospheric parameters taken from the NMC data set (CASTELLARI *et al.*, 1990). The POEM–V data set (August – September 1987) is currently being analyzed to fit the model grid. Objective analysis is being used for the horizontal interpolation while vertical extrapolation through EOFs is being considered since most of the casts do not exceed 2000 m. The model will be forced with the September 1987 – April 1988 twice a day NMC fluxes. Currently, a number of sensitivity tests are being carried out using climatological initial (Levitus or NODC data sets) and forcing data (NMC 1980–1988 monthly climatology). One of the main goals of these customization runs is to investigate the ability of the model to reproduce the main circulation features of the Levantine Sea under different model configurations. A typical summer surface circulation field as reproduced by the model is presented in figure 1. Most of the well known upper thermocline features of the area (ROBINSON *et al.*, 1991) can be recognized, namely : a. The Mid–Mediterranean Jet entering from the west and transporting the Atlantic Water towards the Levantine; b. The Asia Minor Current flowing westrard along the southern coast of Turkey; c. The Rhodes cyclonic gyre bounded by these two jets; d. The extended anticyclonic Mersa–Matruh gyre south of Crete; e. The Shikmona anticyclonic gyre south of Cyprus and f. The West Cyprus cyclone. This realistic circulation field is a significant prerequisite for our LIW formation and spreading studies.



REFERENCES

BLUMBERG A. F and G. L. MELLOR, 1987. A description of a three -dimensional coastal ocean circulation model. Three dimensional coastal ocean models, Vol. 4. edited by N. Heaps, pp.208, AGU, Washington D.C.

CASTELLARI S., N. PINARDI and A. NAVARA, 1990. A realistic general circulation model of the Mediterranean Sea. Part I : Surface energy parametrizations and mcteorological forcing data sets, IMGA–CNR Tech.rep. 4–90, Modena, Italy.

LASCARATOS A., R. WILLIAMS and E. TRAGOU, 1993. A Mixed–Layer Study of the formation of Levantine Intermediate Water, JGR, Vol.98, No.C8, pp. 14,739–14,749

OVCHINNIKOV I.M., 1984. The formation of Intermediate Water in the Mediterranean. *Oceanology*, 24 : 168–173.

ROBINSON A.R., M. GOLNARAGHI, W.G. LESLIE, A. ARTEGIANI, A. HECHT, E. LAZZONI, A.Michelato, E. SANSONE, A. THEOCHARIS and U. UNLUATA, 1991. Stucture and Variability of the Eastern Mediterranean general circulation. DAO, 15 : 215–240.

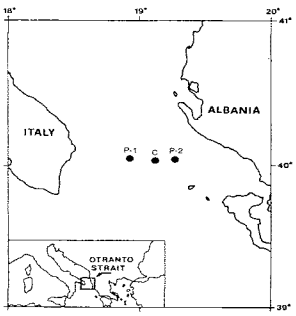
THEOCHARIS A., D.GEORGOPOULOS, A. LASCARATOS and K. NITTIS, 1993 Water masses and circulation in the central region of the Eastern Mediterranean, 1986–1987. *Deep Sea Res.*, II, Vol .40, 6 : 1121–1142.

SEASONAL VARIABILITY OF DYNAMICAL AND THERMOHALINE PROPERTIES IN THE OTRANTO STRAIT AREA - 1989/1990

Nenad LEDER, Ante SMIRCIC and Zvonko GRZETIC

Hydrographic Institute of the Republic of Croatia

From November 1989 to August 1990 four seasonal oceanographic cruises were performed in the Otranto Strait area by R.V. "Andrija Mohorovicic". It is supposed that November, March, May and August are representatives for autumn, winter, spring and summer seasons, respectively. Two current meter arrays were moored in the Strait: the first one near the West coast (P-1) and the second one near the East coast (P-2) (Fig. 1). Current meter data are missing for November 1989. Time series of current data is short, from 1 to 5 days. AANDERAA RCM 4 current meters, with 5 minutes sampling interval, were moored at nominal depths of 5, 50, 100, 200, 500 and 650 m (P-1), and 5, 100, 200, 500, 800 and 930 m (P-2). Wind velocity measurements were registered on board the ship at one hour interval. Some preliminary results of these measurements were presented by LEDER *et al.* (1992). Conductivity, temperature and depth (CTD) measurements were made with SEABIRD SBE 17 profiler at three stations: P-1, P-2 and C (Fig. 1). The CTD data were collected during the downcast at sampling frequency of 24 Hz, with a lowering speed of about 1 m/s. Short period current measurements at two stations in the Otranto Strait indicate two layered circulation, sometimes with only one layer, especially at station P-2. The results are in agreement with VUCAK and SKRIVANIC (1986), FERENTINOS and KASTANOS (1988) and MICHELATO and KOVACEVIC (1991) results, obtained also by direct current measurements. General characteristic of the flow is very high intensity. The most intensive flow is usually between 500 m and 800 m. Maximum current speeds were registered at station P-1 at the depth of 500 m in March 1990 (64 cm/s), while at station P-1 at the depth of 5 m in May 1990 (49 cm/s). Measurements in March and May 1990 supported well known structure of exchange of water masses in the Otranto Strait, with inflowing (northward) currents along the Albanian coast, and outflowing (southward) currents along the Italian coast. Such current regime can be called "typical situation". Meanwhile, in August 1990, an opposite nontypical exchange of water masses was registered, with outflowing current along the Albanian coast and inflowing current along the Italian coast. In typical situation inflowing currents were more intensive and stable than the outflowing ones, while in nontypical situation inflowing currents along the Italian coast were more intensive and unstable than outflowing currents along the Albanian coast. At both stations currents were stronger in typical, than in nontypical situations.



Thermohaline properties in the Otranto Strait are subject to seasonal and inter-annual variabilities (BULJAN and ZORE ARMANDA, 1976). Seasonal variability (season 1989/1990) of temperature, salinity and sigma-t at station P-2 is shown in Fig. 2. It is obvious that only surface layer (about 100 m) changes its thermohaline properties, while the rest of the water column has properties of the unique, unchangeable water mass, denoted by ZORE ARMANDA (1963) as A type of the water mass (T=14°C, S=38.7 psu, sigma-t=29.06). This water mass is a result of mixing of the more saline Levantine Intermediate Water (LIW) with the Adriatic Water (J type), therefore it is called Modified Levantine Intermediate water (MLIW). Formation of MLIW in the Otranto Strait indicates that the Adriatic Sea will not be influenced by the phenomenon called "Adriatic ingression" (BULJAN and ZORE ARMANDA, 1976) which is observed in situations when LIW water mass is as dense as the Adriatic water, does not sink and enters the Adriatic unchanged, with salinity higher than 38.8 psu. Vertical profiles of temperature, salinity and sigma t (Fig.2) show that the water column in the Otranto Strait is almost permanently stratified, especially in the surface layer. An interesting phenomenon is the occurence of subsurface salinity minima at the level of seasonal thermocline (Fig.2). The most pronounced salinity minimum was observed in November 1989, coinciding with the dissolved oxygen maximum. A possible explanation is that the ventilation process was due to Ekman pumping produced by the curl in N and NE wind (Bora wind) measured on board the ship a few days before the sampling in the Otranto Strait. A similar process was documented and analyzed by BERGAMASCO and GACIC (1992) in the Southern Adriatic. At station P-1, temperature and salinity are lower than at station P-2, especially in the surface layer, because station P-1 is situated in the vein of cold and fresh water, outflowing the Adriatic Sea along the Italian coast. Thermohaline data at station C (Fig.1) show that this position varies in relation to the outflowing inflowing current system, sometimes being in inflowing and sometimes in outflowing current. Occurence of salinity "patches" suggests turbulent mixing in the zone between currents of opposite directions.

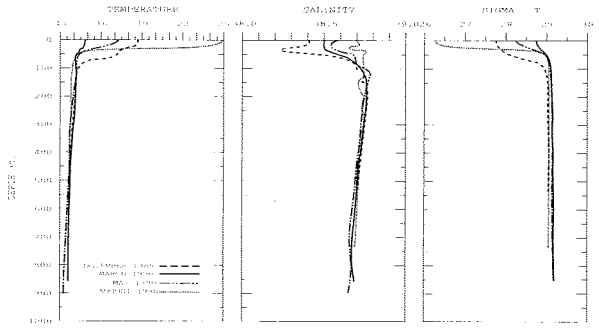


Figure 2. Annual course of temperature, salinity and sigma-t in the Otranto strait, station P2

REFERENCES

BERGAMASCO A. and M. GACIC, 1992. *Rapp. Comm. int. Mer Medit.*, 33: 329.

BULJAN M. and M. ZORE ARMANDA, 1976. *Mar. Biol. Ann. Rev.*, 14: 11-98.

FERENTINOS G. and N. KASTANOS, 1988. *Continental Shelf Research*, 8: 1025-1041.

LEDE, N., A. SMIRCIC, M. FERENCAK and Z. VUCAK,1992. *Acta Adriatica*, 33, in press.

MICHELATO A. and V. KOVACEVIC, 1991. *Bol. di oceanologia teorica ed applicata*, 9: 39-51.

VUCAK Z. and A. SKRIVANIC. 1986. Hidrografski godisnjak 1984-1985 : 85-102.

ZORE ARMANDA M., 1963. *Acta Adriatica*, 10 (3) : 1-38.

SATELLITE OBSERVATIONS OF SEA SURFACE TEMPERATURE FRONTS OFF SICILY DURING SUMMER 1992

Carolina LODDO[1], Gianluca BORZELLI[1], Salvatore MARULLO[2], Rosalia SANTOLERI[3]

[1] Telspazio S.P.A., Earth Observation Depart., Via Tiburtina 965, 00156-Roma, Italia
[2] ENEA/CREA, Casaccia -C.P.2400, 00100-Roma, Italia
[3] CNR/IFA Piazz.le Sturzo 15, 00100-Roma, Italia

Satellite Advanced Very High Resolution Radiometer (AVHRR) data were used to analyze the sea surface temperature patterns off Sicily during summer 1992. About 60 day-time images were analyzed showing a cold front emerging from the Sicilian coast. Satellite images were navigated (i.e. corrected for receiving systems timing errors, satellite altitude, tilting and twisting errors), corrected for Limb darkening, for atmospheric attenuation and, finally, remapped on common cartographic projection. Since most of the available NOAA data were day-time passes the selection of the best images was seriously limited by the occurrence of several diurnal warming events. Temperature differences inside-outside the upwelled front have been estimated to be about 5 degrees. The upwelling front forms between June 25th and June 28th. The cold front was rich of filaments, meanders and mushroom-like structures; the main filament was observed off Trapani elongating towards Lampedusa island for about 100 km and its off-shore motion appears to be strongly related with bathimetry. The windy nature of this filament is presently under investigation: it is believed that the Sicilian orography may partially screen a North blowing wind inducing an asymmetrical wind profile beyond Sicily able to communicate to the sea the relative vorticity required to form the filament. Therefore, this filament is supposed to be an important feature of the whole upwelling front. Indeed, the filament formation is a necessary condition for the upwelling front formation. Moreover these observations rise an important question on the different time scales on which the wind supply relative vorticity to the sea and forms upwelling structures in the Channel of Sicily. Wind data are currently under study, as station data do not posses the synoptic characteristics such to evaluate the wind curl beyond Sicily, data from ERS-1 scatterometer is currently being analyzed in order to supply a qualitative synoptic view of the wind regime in the Channel of Sicily.

FLUXES IN THE BALEARIC CHANNELS

J. L. LÓPEZ-JURADO

Instituto Español de Oceanografía, Centro Oceanográfico de Baleares
Palma de Mallorca, Spain

Superficial and intermediate water fluxes, through the Balearic channels, have been calculated and studied, in order to contribute to the knowledge of the water masses circulation and mesoscale variability, in two consecutive Mediterranean sub-basins.

A data set from three cruises carried out, in the Balearic channels, during March, May and June 1993, were used to calculate these fluxes. Table I shows preliminary net results.

Superficial northward fluxes close to 0.5 Sv, point out the importance of Modified Atlantic Water (MAW) input in this area. The values imply that under certain circunstances, an important percentage of the MAW output from the Alboràn sea, reach the Balearic Islands, possibly transported by processes adsociated with the Almerian-Oran front instability or by mesoscale processes associated with the Argelian Current.

In the same way, Levantine Intermediate Water fluxes (LIW) show seasonal features in relation with the Ligur-Provenzal-Catalan current and the Winter Intermediate Waters are shown to be seasonal.

This flux data set when compared to historical data, shows a high interanual variability.

	IBIZA CHANNEL			MALLORCA CHANNEL		
	N	S	NET	N	S	NET
MARCH 93	+0.366	-0.808	-0.442	+0.907	-0.432	+0.475
MAY 93	+0.946	-0.690	+0.256	+0.607	-0.225	+0.382
JUNE 93	+0.532	-0.575	-0.043	+0.543	-0.143	+0.400

REFERENCES

GARCIA LAFUENTE J., CANO N., LOPEZ-JURADO J.-L., 1994. Water masses circulation through the Ibiza channel. *Oceanologica Acta* (in press).

LA VIOLETTE P., TINTORE J., FONT J., 1990. The surface cirulation of the Balearic Sea. *Journal of Geophysical Research*, Vol. 95 (NO C2) : 1559-1568.

LOPEZ-JURADO J.-L., GARCIA LAFUENTE J. and CANO N., 1994. Hydrographic conditions of Ibiza channel during November 1990, March 1991 and July 1992. *Oceanologica Acta* (in press).

PERKINS H. and PISTEK P., 1990. Circulación in the Algerian Basin during June 1986. *Journal of Geophysical Research*, 95 (N° C2) : 1577-1585.

POTENTIAL ENERGY ANOMALY AND HEAT DISTRIBUTION IN THE GULF OF TRIESTE (NORTHERN ADRIATIC) DURING THE SPRING-AUTUMN PERIOD

V. MALACIC[1], M. CELIO[2] and A. SLOSAR[1]

[1] Marine Biological Station, Piran, Slovenia
[2] Laboratorio di Biologia Marina, Trieste, Italia

The distribution of Potential Energy Anomaly -PEA- (ELLIOT and CLARKE, 1991) and heat content of the Gulf of Trieste were deduced from the thermohaline structure recorded in the frame of the Alpe Adria project from 1991 to 1993.

In the northern shallower part of the Gulf of Trieste, where the depths are less than 10 m, the PEA reaches higher values than those in the southern part of the gulf due to the spring and autumn pronounced riverine outflows. During the spring-autumn period the only efficient agent for mixing the water column is the wind. Estimations of mixed areas are obtained from charts of PEA distribution calculated at several depths and from wind data. In periods of low wind intensity the energy supplied by wind may not be sufficient to mix thesurface part of the water column.

In periods of pronounced peaks of riverine discharge the surface part of the water column is almost in geostrophic equilibrium and other nonlinear terms together with the term of local acceleration in the equation of motion may contribute up to 10% of Coriolis term. Therefore, the first approximation of water transport based on a stationary geostrophic equilibrium sounds reasonable. The procedure for the calculation of the barotropic and baroclinic components of volume transport is developed. The barotropic component depends on the horizontal gradient of vertically averaged density, while the baroclinic component is proportional to the gradient of PEA. The relation between the PEA and the JEBAR term (MERTZ and WRIGHT, 1992), which plays a role in a depth-averaged vorticity equation, is also analyzed.

REFERENCES

ELLIOT A. J. and CLARKE T., 1991. Seasonal stratification in the northwest European shelf, *Cont. Shelf Res.*, 11 : 467-492.

MERTZ G. and WRIGHT D.G., 1992. Interpretation of the JEBAR term, *J. Phys. Oceanogr.*, 22 : 301-305.

SEASONAL AND INTERANNUAL VARIABILITY OF THE SEA SURFACE TEMPERATURE FIELD IN THE EAST MEDITERRANEAN SEA FROM AVHRR DATA

S. MARULLO[1], R. SANTOLERI[2], P. M. RIZZOLI[3], A. BERGAMASCO[4]

[1] Ente per le Nuove tecnologie, l'Energia e l'Ambiente, Centro Ricerche, Casaccia, Roma, Italy
[2] Istituto di Fisica dell'Atmosfera, CNR, Roma, Italy
[3] Massachusetts Institute of Technology, Department of Earth, Atmospheric and Planetary Science, Cambridge, Massachusetts, USA
[4] Istituto per La Dinamica delle Grandi Masse, CNR, Venezia, Italy

The increased availability of long time series of satellite data makes possible to investigate the seasonal and interannual variability of the sea surface temperature field over many areas of the world oceans. This is particularly true for those mid latitude regions, like the Mediterranean Sea, where the field of view of infrared sensors is not so frequently obscured by clouds as for other areas.

The NODS/MCSST used in the present work are 18 x 18 km weekly averaged SST maps for the period September 1981 - December 1992. Monthly and seasonal SST maps were produced from these data using objective analysis techniques and averaged over 11 years to evidentiate the seasonal behaviour of the SST field.

The analysis of the monthly climatological maps reveals that SST distribution is zonal from November to April and meridional in the period June-September. May and October are the transition months for the two situation.

The winter to summer transition should happen between May and June and is clearly marked by the northward displacement of the isotherms in the gulf of Sirte with the consequent formation of a meridional thermal front at about 210 E.

From October to November, during the summer to winter transition, the Ionian-Levantine front becomes weaker and less meridional. At the same time the Ionian warm meander starts to droop.

The analysis of the averaged months indicates that inflow of surface Atlantic water should be more intense from July to January when isotherms can directly proceed from the West to the East Mediterranean. The exchange of the modified Atlantic water between the Ionian and Levantine basins is inhibit from July to September by the summer growing of the cold core gyre west of Crete and by the formation of the 210E thermal front.

Moreover, the analysis of the monthly SST maps allows us to classify the permanent or semi-permanent thermal structures and study their seasonal characteristics in relation to basin main pattern.

In order to evaluate the interannual variability of the main dynamic structures of the eastern Mediterranean during the period 1982-1992, we constructed seasonal maps for individual years. These seasonal maps enable us to establish the extent of interannual SST pattern variability and how the variability effects the main features of the Eastern Mediterranean Sea. We observed a strong interannual variability in the whole eastern Mediterranean Basis either terms of absolute sea surface temperature or dynamic features intensity and shapes. Moreover this variability also shows differences and peculiarities in each sub-basin.

Empirical orthogonal function analysis (EOF) was applied to the 11-years sequence of AVHRR images to identify the dominant patterns of the SST variability in the eastern Mediterranean Sea. Singular Value Decomposition (SDV) has been used instead of the formal covariance method because computationally more efficient. Seasonal signal (rather than space or time average) was removed from each image before the SVD computation in order to retain interannual variability. The function used to describe the seasonal behaviour of the SST is where t is the time T is one year period and a, b, c, d parameters that have been estimated by non-linear fit using Lavenberg-Marquard method. EOF modes were calculated separately for the Ionian and Levantine Basins. In Both basin the first four EOF mode explain 87-88% of the total variance. The spatial pattern of the first EOF mode (46-50% of the total variance) in the two basins is very similar to the mean temperature field from averaging over all images. The second EOF mode (31 - 27% of the total variance) is similar to the first in the Ionian Sea while evidentiate sub-basin dynamic structures in the Levantine Basin as well as the main jet at middle of the basin. The third EOF mode (6-9% of the total variance) show the summer meridional distribution of the SST filed in the Ionian Basin, while in the Levantine Basin small scale features dominate. In this third EOF mode a large meander appears in the Mersa-Matruh area. The temporal variance EOF mode amplitude functions clearly show seasonality and interannual variability. Seasonality is more evident in modes 1, 3 and 4 while interannual variability clearly appears in mode 2. It is noteworthy that EOF modes interannual variability shows differences from season to season. This is particularly true for the second EOF winter mode. It shows 3 interesting minima in 1983, 1987, 1992 that are all winters that follows a previous El-Nino December. These three minima also correspond to minima in the SST time series, but it is even more interesting to note that they also corresponds to SST fields less rich of sub-basin features and spatial gradients.

MEDITERRANEAN TIDAL CURRENTS: A QUALIFICATION OF CURRENT METERS PERFORMANCES

Claude MILLOT, Stephan ROUSSEAU and Corinne ALBEROLA

Centre d'Océanologie de Marseille. Antenne COM, BP 330, F-83507 La Seyne/mer

Calibrating current sensors in the lab needs sophisticated equipments and a qualified staff. Therefore, nearly all teams use standard calibrations provided by the manufacturer. However, mechanical sensors used on most of the instruments wear from year to year. They can also suffer from damages. Besides, deep measurements in the western Mediterranean Sea have evidenced currents of several tens of cm/s. The occurrence of such large currents at depth overthrows generally accepted ideas. Therefore, an in situ qualification of current measurements is needed. Surprisingly, this is a very easy task which provides an extremely accurate calibration of the sensors.

Tidal currents in the interior of the ocean are mostly barotropic. Therefore, any location is associated with specific values of the amplitude and phase of each tidal component. Harmonic analyses technics have been proved very efficient to compute these values. Nevertheless, in most of the ocean, tidal currents are relatively large. This is especially the case at depth, when they are compared to longer time scale currents as, for instance, those due to the general circulation. Because of the threshold of a mechanical speed sensor, when tidal currents are relatively large, the change in direction they induce will be associated with an overestimated speed value. On the contrary, when tidal currents are relatively low, as in the Mediterranean Sea, they only induce small variations of the speed and direction of the recorded current. In this case, the efficiency of harmonic analysis extends to the utmost.

A lot of mechanical current meters have been moored over the whole western Mediterranean Sea allowing the computation of tidal currents (ALBEROLA *et al.*, 1994). In the interior of the Algerian Basin, relatively long time series have been collected at different depths and locations. This allows a statistical analysis of the amplitude and phase of the M2, S2 and N2 tidal components. It is demonstrated that amplitudes as low as a few mm/s can be accurately computed together with phases which accuracy is a few degrees. This provides a qualification test for current meters and accounts for their generally good performances.

REFERENCES

ALBEROLA C., S. ROUSSEAU, C. MILLOT, M. ASTRALDI, J. FONT, J. GARCIA-LAFUENTE, G.P. GASPARINI, A. VANGRIESHEIM, U. SEND, 1994. Tidal currents in the interior of the western Mediterranean Sea. Submitted to *Oceanol. Acta* for the PRIMO Special Issue.

CHLOROPHYLL DYNAMICS OF THE NORTHERN ADRIATIC STUDIED FROM SATELLITE DATA

Mira MOROVIC

Institute of Oceanography and Fisheries, 58000 Split, P.O.Box 500, Croatia

Satellite chlorophyll dynamics from the Northern Adriatic was studied from around 30 satellite images. Studied region is presented in the figure 1. Satellite chlorophyll data from this paper were CZCS data, processed by JRC-ESA software for the chlorophyll within the frame of the OCEAN project. Temporal and spatial distribution and changes of satellite chlorophyll data were analyzed together with the Po river discharge and other parameters in order to find relationships of the physical environment to the sea water chlorophyll and determine the most powerful driving forces of chlorophyll dynamics.

Fig.1. Studied region.

Analysis was performed for chlorophyll means from areas from different spatial scales from the Northern Adriatic EOF analysis (PREISENDORFER, 1988) was also done to study different aspects of variability in terms of eigen motions and amplitudes. In most of the cases only first two modes were significant (MOROVIC *et al.*). First mode (the greatest variability of the process) was found to be correlated with the global radiation (fig.2).

Second mode was probably correlated with the Po river discharge. Some differences were found between different regions of the Northern Adriatic. Varying the size of averaged area (scaling), it was possible to find the range of influence of different parameters and differences in variability on different scales.

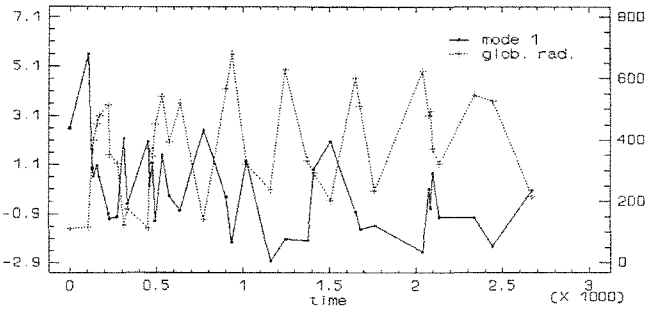


Fig.2.First mode amplitudes and global radiation

REFERENCES.

PREISENDORFER R.. W., 1988. Principal component analysis in meteorology and oceanography. Elsevier. Amsterdam. 425p.

MOROVIC M., B. GRBEC and V. DADIC. Significant variabilities of the physical processes in oceanography (in preparation).

A NUMERICAL STUDY OF THE AEGEAN SEA GENERAL CIRCULATION

K. NITTIS, A. LASCARATOS and L. PERIVOLIOTIS

University of Athens, Department of Applied Physics, Laboratory of Meteorology and Oceanography, Athens, Greece

The general circulation of the Aegean Sea, its response to different forcing factors and its seasonal variability are studied in a series of model experiments. We use the Princeton Ocean Model (POM), designed by BLUMBERG & MELLOR (1987). In our implementation of the model we use a 50 x 50 curvilinear grid with varying grid size (5 km in North Aegean to 28 km south of Crete) and 16 levels of vertical resolution. The combined NODC–BNDO data set is used to initialize the model runs. The data are mapped onto the model grid using objective analysis techniques and their annual mean were used as initial conditions. For the open boundaries, seasonal T and S profiles were computed for the same data set at each grid point. Wind stress, heat and fresh water fluxes are interactively computed from the model's SST and climatological atmospheric parameters (wind speed, air temperature and relative humidity) taken from the NMC (CASTELLARI *et al.*, 1990). The precipitation data used were provided by D. LEGATES & C. WILLMOTT (1990). The inflow of the Black Sea waters in the Aegean through the Dardanelles straits was simulated as a source of low salinity water (S=28 psu) with constant flux throughout the year (10000 m^3/sec).

The results indicate that the wind stress is the main driving mechanism in the area but the introduction of thermal and fresh water surface fluxes enhanced the seasonal variability of the features. Under this combined forcing, the model successfully simulated the general circulation of the area and the formation of the main Aegean water masses. The winter circulation pattern proposed by OVCHINNIKOV (1966) for the whole area, seemed to be in good agreement with the model results. In Cretan Sea a large cyclonic gyre exists, while in the North Aegean a multi–system cyclonic pattern is observed. The surface water masses enter the Aegean from the Rhodes straits and contribute to the cyclonic circulation in the two parts of the basin. The summer surface circulation appears to be mainly anticyclonic. This reversal of the flow in the Cretan sea, between winter and summer, was one of the major findings of the POEM cruises in the area. A strong inflow is observed now in the western straits of the Cretan arc and the water masses move along the west coasts of Greece toward the central and northern Aegean. In Hios basin the flow is separated in two branches: one turns to the east and then southwards parallel to the coast, exiting Aegean from Rhodes–Karpathos straits; the other moves further north forming a double–gyre system, similar to the one proposed by HOPKINS (1978) (cyclonic to the West, anticyclonic to the East).

According to model results, the North Aegean sea, especially its eastern part, is an area of deep water formation, as suggested by various authors (LACOMBE *et al.*,1958; MILLER, 1974). A homogenization down to 600 m observed in February with minimum temperature value of 12.9 degrees, while in June in the same area the temperature of deep waters is 12 degrees, in total agreement with the observations of LACOMBE (1958). In both cases the salinity remains the same at these depths, near 38.7 psu. It seems that the deep waters of the North Aegean trough are not formed locally, since the lowest deep temperatures are observed in summer, but are produced remotely in the northern Aegean shelf area and are then advected to the deepest parts of the trough. These dense waters seems to move towards the southern Aegean through the relatively shallow (~400 m) plateau of Cyclades, as seen in the vertical transects across the straits that connect the North and South Aegean. As these waters move southward their characteristic signal decreases in strength and by the time they reach the Cretan Sea no observable sign persists.

Although in its present configuration the model is not eddy resolving, there are clear indications in the results, of a highly energetic mesoscale field associated with the general circulation especially in the northern Aegean. We are currently implementing an eddy resolving version of this model.

REFERENCES

BLUMBERG A. F. and G. L. MELLOR, 1987. A description of a three–dimensional coastal ocean circulation model. Three–Dimensional Coastal Ocean Circulation Models, Coastal Estuarine Sci., 4, edited by N.S. Heaps, pp 1–16, AGU, Washigton D.C. 1987

CASTELLARI S., N. PINARDI and A. NAVARA, 1990. A realistic general circulation model of the Mediterranean Sea. Part I: Surface energy parameterizations amd meteorological forcing data sets, IMGA–CNR Tech. Rep. 4–90, Modena, Italy.

HOPKINS T., 1978. Physical processes in the Mediterranean basins, Estuarine Transport Process, 269–307.

LACOMBE H., TCHERNIA P. and BENOIST G., 1958. Contribution à l'étude hydrologique de la mer Egée en période d'été. *Bull. Inf. COEC* 8 : 454–468.

LEGATES D.R. and C.J. WILLMOT, 1990. Mean seasonal and spatial variability in gauge–corrected, global precipitation. *Int. J. of Climatol.* V10 : 111–127.

MELLOR G.L. and T. YAMADA, 1982. Development of a turbulence closure model for geophysical fluid problems. *Rev. Geophys. Space Phys.*, 20 : 851–875.

OVCHINNIKOV I. M., 1966. Circulation in the surface and intermediate layers of the Mediterranean. *Oceanology*, 6 : 48–59.

THE MAIN ENERGETICALLY ACTIVE ZONES OF THE BLACK SEA

I. M. OVCHINNIKOV, V. B. TITOV, V. G. KRIVOSHEYA

The Southern Branch (Gelendzhik) of the P. P. Shirshov, Institute of Oceanology of the Russian Academy of Sciences, Russia

The intensive vertical water exchange between the deep and surface waters takes place in the middle of large-scale quasi-stationary cyclonic gyres in the central part of the Black Sea. The rising of deep waters results from a kinematic effect. Their average perennial volume is equal about 3000 km /year. In winter, when the cyclonic circulation becomes more active, the upper boundary of the deep waters in the centres of cyclonic gyres may rise to the depth of 25-30 m. With the deep waters biogenous elements and hydrogen sulfide surplus produced in the water column, rise into the surface layer where H_2S is oxidized. In such a way the biological productivity of the upper layer and the dynamical balance between the processes of producing and oxidation of H_2S are maintained. The deep water rising forms a vast central divergence zone (CDZ) passing through the centres of cyclonic gyres (OVCHINNIKOV *et al.*, 1993).

In the centres of cyclonic gyres where the thickness of the upper active layer and its heat reserve are minimal (due to deep water rising), during the autumn-winter cooling (thermohalinic convection) the intensive mixing and sinking of surface waters down to the pycnocline dome occurs. In the process of their interaction with the deep waters (5/1 or 6/1) the waters of cold intermediate layer (CIL) are formed, and at the same time the oxigen for the rising H_2S oxidation is supplied. This process is accompanied by the intensive energy exchange between the sea and atmosphere, that gives the reason to consider these regions to be the Black Sea energetically active zone (OVCHINNIKOV *et al.*, 1993).

The internal waves with mesoscale periods which are actively developed on the main pycnocline domes, contribute to the most energetic interaction between the surface and deep waters.

In the nearshore zone, between the midstream of the Rim Cyclonic Current (RCC) and the shore, there is a quasi-stationary system of nearshore anticyclonic eddies (NAE) covering the whole sea coast along its perimeter (OVCHINNIKOV, TITOV, 1990; OGUZ *et al.*, 1992). They are formed owing to anticyclonic vorticity of the current field at the expense of the lateral shear (horizontal gradient) of velocity between the RCC midstream and the steep nearshore slope of the bottom. The nearshore convergence zone (NCZ) where the kinematic sinking of water takes place, is passing through the centres of the NAE having convergence properties. On the other hand, the nearshore area is a periphery of quasi-stationary cyclonic gyres where the kinematic sinking of water occurs. The superposition of NCZ upon this area stipulates the intensive sinking of the nearshore waters there (OVCHINNIKOV, TITOV, 1990).

The regions of deep water rising in the CDZ and surface water sinking in the NCZ are communicated and form a single closed system of the transverse circulation. In this system of circulation the water rising in the CDZ is compensated by the water sinking in the NCZ. Yet the compensation of rising waters is not carried out by their direct transport from the region of sinking, but through a complex lateral turbulent exchange in the system of eddies of various size.

The fundamental importance of the transverse circulation system for the ecology of the Black Sea consists in the following. If the extent of the anthropogenous contamination does not exceed the natural capability of the sea to the self-purification, the contaminated waters, sinking in the nearshore zone, are purificated gradually during their moving to the centre of the Basin and improve the ecological conditions of waters in the region of their rising. If the extent of the anthropogenous contamination exceeds the natural potential of self-purification, then the sinking contaminated waters having passed through the system of transverse circulation, will close the cycle of the whole sea contamination including its deep waters, that may lead to the irreversible ecological catastrophe of the Black sea (OVCHINNIKOV, TITOV, 1990; TITOV, 1992).

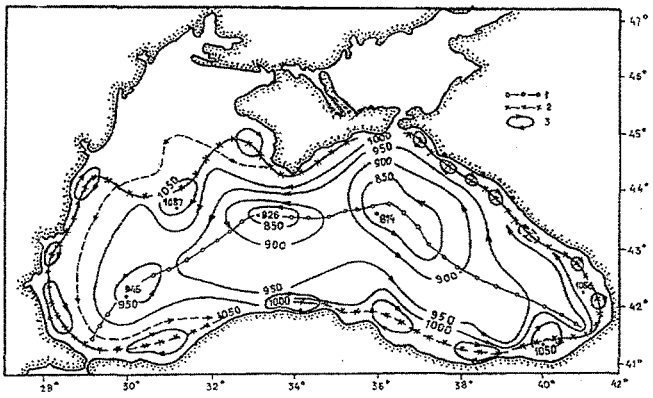


Figure: Dynamical topography of the Black sea surface relative to 200 dbar depth and its main energetically active zones: the central divergence zone (1), the nearshore convergence zone (2) and the nearshore anticyclonic eddies (3).

REFERENCES

OGUZ T., P. E. LA VIOLETTE, U. UNLUATA, 1992. *Journal of Geophysical Research*, 97, C 8 : 12569-12584.

OVCHINNIKOV I. M., V. B. TITOV, V. G. KRIVOSHEYA, YU.I . POPOV, 1993. *Oceanology*, 33, 6 : 801-807.

OVCHINNIKOV I. M., V. B. TITOV, 1990. *Doklady Akademii Nauk* USSR, 314, 5 :1236-1239.

TITOV V. B., 1993. *Oceanology*, 33, 4 : 521-526.

THE SECULAR VARIATION OF WINTER TEMPERATURE OF AIR IN THE NORTH-EASTERN PART OF THE BLACK SEA

I. M. OVCHINNIKOV, V. B. TITOV

The Southern Branch of the Institute of Oceanology of the Russian Academy of Sciences. Gelendzhik. Russia

Secular series of the mean monthly temperature of air at four points of observations on the coasts of the Crimea and North Caucasus, and for comparison in Odessa and Sukhumi, were assumed as basis of studies of winter climatic conditions in the north-eastern part of the Black Sea. The most cold months of January and February were assumed to be the typical pure winter months and their mean temperature (T°) to be the winter temperature of air (Figure 1, a). The graphic and spectral analysis of T°secular series at each point of observations showed that climatic peculiarities of the Black Sea in the cold season are characterized by a well-defined short-period variation from 2.2 to 4.4 years, weak manifestation of eleven-year sun cycle and distinet twenty-year fluctuations (19.2 years). In order to get the most clear regularities in the secular variation of T°we had to turn to its filtration by the five-year sliding averaging. The graphs of smoothed winter temperature of air (T*°) appeared to be similar for all six points of observations, and correlation coefficients of T*°between the different points of observations are close to 1. It is indicative of the unity of atmospheric processes not only over the north-eastern part of the Black Sea but also over the most its aquatory. That is why for the further analysis of climatic variation the smoothed winter temperature of air in the port of Novorossiisk is given by way of example (Figure 1,b).

As is seen from Figure 1,b, in T*°variation one can also trace the long-time periodicity which is nearly 20 years. In this case the duration of its positive and negative deviations (warm and cold cycles) from the mean secular winter temperature of air (from a "standart" TN°= 2.7°C) equals about 10 years. So in more than secular (121 years) series of winter temperature of air under study in the port of Novorossiisk, five complete and well-defined twenty-year fluctuations are traced with ten-year warm and cold cycles. That is why the processes of vertical interaction between the surface and deep waters in the centres of main cyclonic gyres of the Black Sea, being in direct relation with the "severity" of winter conditions, undergo mostly the same long-time variation in the cold intermediate water (CIW) formation. During cold cycles a considerable intensification of winter convection, kinematic deep water rising and other hydrophysical processes take place here which favour the active formation of the cold intermediate layer in the Black Sea. In this case the volume of anomally cold intermediate water (CIW; 5-6°C) is sharply increased, hydrogen sulphide oxidation grows, and its upper boundary is noticeably lowered, much more biogenic elements are withdrawn from the deep waters into the surface layer, and therefore its productivity is considerably increased. At the same time the surface waters are replenished and renewed due to rising of relatively clean deep waters. Such a cold cycle favourable for the whole ecosystem of the Black Sea is supposed to start at the beginning of the nineties. On the contrary, during the warm cycles all the proces- ses become weak that has a negative influence upon the ecosystem of the whole Basin. Such a warm cycle with the total positive deviation of T*°equal to 13.2°C was observed in the first half of the eighties and brought a lot of troubles into the Black Sea ecosystem.

But the warm and cold cycles in twenty-year T*°fluctuations are revealed irregularly that is well reflected in the total deviations of T*°from TN°in these cycles (Figure 1,b). As the result of such irregular T*° fluctuations in the period under discussion, a considerable surplus of its positive deviations was accumulated which is equal to +11.2°C. In this case a stable trend (Figure 1,b; a broken line) is traced from the thirties to nineties which is characterized by the winter temperature of air rising by 2.25°C in Novorossiisk area. Such T*°rising during the last 60 years had to be reflected in the weakening of thermodynamical processes and, as a consequence, in the oppression of the Black Sea ecosystem.

Considering winter processes in the Black Sea, we must notice that in this season 3000 km^3 of deep water on an average penetrate into the surface layer through a weakened pycnocline (OVCHINNIKOV, POPOV, 1987). This volume exceeds by the order of magnitude the largest components of this Basin water balance. Hence it is obvions how important is the role of the deep waters in the formation of the Black Sea upper active layer.

In this way, the revealed regularities of variation of winter climatic conditions make possible the long-period prognosis of hydrogen sulphide contamination of the deep water and the ecological situation of the Black Sea as a whole.

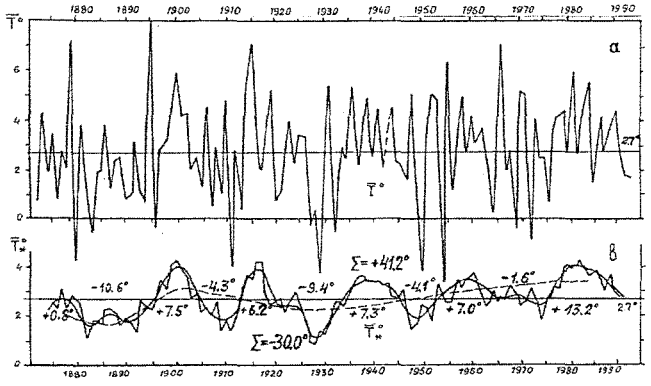


Figure 1. Variation of mean winter temperature of air ($T°=(t_1°+t_2°)/2$) in Novorossiisk over the period from 1872 to 1993 (a). T*°variation obtained by five-year sliding averaging of T over the same period (b).

REFERENCES

OVCHINNICOV I. M.,POPOV YU. I., 1987. *Oceanology*, t.27, N 5, p. 739-745

OVCHINNICOV I. M., OSADCHY A. S. 1991. Ecosystem of the Black sea variation. Moscow, Nauka, p.85-89.

BAROTROPIC ASPECTS OF THE TYRRHENIAN CIRCULATION

Stefano PIERINI

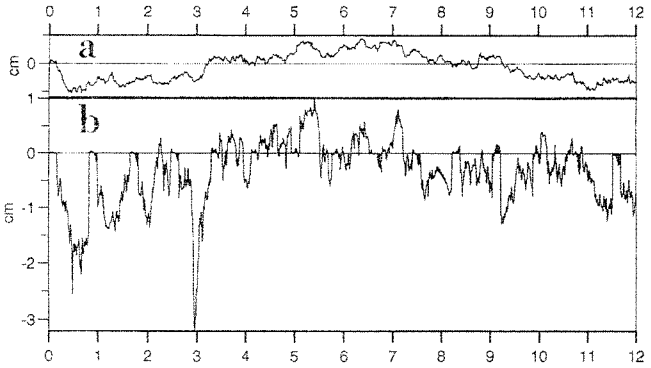
Istituto di Meteorologia e Oceanografia, Istituto Universitario Navale, Corso Umberto I, 174, 80138 Napoli, Italia

A shallow water model for a homogeneous incompressible fluid is implemented in domains representing the central Mediterranean and the Tyrrhenian sea in order to perform process oriented studies on the high frequency barotropic transport in the straits of Sicily and on the wind-driven circulation in the Tyrrhenian sea, respectively.

As far as the central Mediterranean is concerned, the system is excited (a) by a prescribed flow through the western and eastern "open" boundaries (the straits of Sardinia and the Ionian sea) thus simulating a remote pressure forcing, (b) by a wind stress curl -both forcings having a white temporal structure ranging from 0.5 to 20 days- and (c) by a wind set up that is then allowed to relax.

Several peaks are found in the power spectrum of the response within the strait, both of irrotational and rotational character. The irrotational motions give a substantial contribution to the total fluctuating transport in the strait. Rotational peaks at 2.2, 2.8, 3.5 and 6.1 days are found, no matter what forcing is used. They are travelling quasigeostrophic motions localized north of Tunisia and in the strait. We suggest that they aretopographic Rossby modes supported by the topographic variation north of Tunisia and Sicily and within the strait and constricted by theadjacent coasts. A simple calculation based on the formula for non-divergent Rossby modes in a closed basin gives theoretical eigenperiods for rectangular basins defined by the geographical limits just defined that are very close to those found in the spectroscopic analysis. It is to be noticed that the topographic beta effect is much larger than the planetary beta effect, the latter being virtually negligible.

The study of the wind-driven circulation in the Tyrrhenian sea is part of a research project in the framework of the EEC-MERMAIDS II program, aimed at analysing the barotropic response to the wind stress in Mediterranean subbasins. A "closed" Tyrrhenian sea with a spatial resolution of about 1/4 degree (25 km) is forced by the twice daily, 1 x 1 degree National Meteorological Center (Washington, DC) momentum flux data. The wind data are linearly interpolated spatially onto the regular model grid and temporally between two sampling times. In Fig. a, the time series of the sea surface displacement in the middle of the basin is presented for the perpetual year forcing computed by averaging the instantaneous winds over the 9 available years (from 1980 to 1988). One has a typical cyclonic circulation during winter and an anticyclonic regime with smaller regions of cyclonic circulation from April through August. These results are in substantial agreement with those of ROUSSENOV, STANEV, ARTALE and PINARDI (1993). They found that -in the framework of a GCM of the whole Mediterranean with realistic atmospheric parameters- the Tyrrhenian sea exhibits a seasonally "recurrent gyre" of this kind, which is considered as peculiar of the Mediterranean barotropic general circulation.



Moreover the present free surface model is able to describe the rapid barotropic adjustment to the fluctuating winds. As an example the time series relative to the 1981 year forcing is presented in Fig. b (same scale as in Fig. a). It is evident the large variance of the signal compared to that of the climatological year. Such an information on the high frequency variability can be relevant for passive tracer dispersion studies, for which a knowledge of the basic velocity field in the whole frequency domain can turn out to be fundamental to obtain correct lagrangian trajectories and, therefore, to achieve correct dispersion estimates.

SINKING OF THE LEVANTINE INTERMEDIATE WATER IN THE TYRRHENIAN BASIN

P. PISTEK[1], G. P. GASPARINI[2], M. ASTRALDI[2], S. SPARNOCCHIA[2] and E. LAZZONI[2]

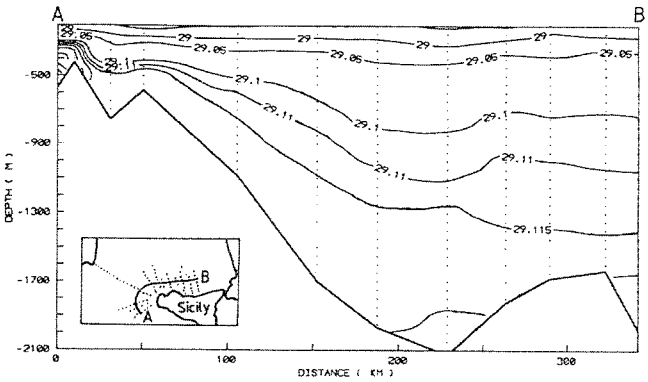
[1] NOARL, J. Stennis Space Center, Bay Saint Louis, USA
[2] CNR, Stazione Oceanografica, Pozzuolo di Lerici, Italia

The Tyrrhenian Basin is a semi-enclosed basin whose most important opening is the Sardinia- Sicily cross-section. The Levantine Intermediate Water (LIW) inflows only through this passage, along the Sicilian coast (KRIVOSHEIA and OVCHINNIKOV, 1973).

Intensive hydrographic surveys and long term current measurements in the Southern Tyrrhenian basin permitted to evidence a direct connection between the LIW outflowing from the Strait of Sicily and the LIW water entering the Tyrrhenian Sea. The current is characterized by a well developed mean flow entering the Tyrrhenian basin year round, but with higher values during the cold season. While a part of it flows at the canonical depth for this type of water, a considerable volume was seen to sink from about 300 m at the sill strait to more than 1800 m of depth, where it follows the isobaths and can be clearly observed as far as the Eolian Isles. This vein was observed in different seasons and its characteristics can be considered largely stable year round.

In the Sicily channel, the LIW has a σ_θ of about 29.10 or more, while in the Tyrrhenian sea, at the same depth (300-400 m), σ_θ ranges between 29.00 and 29.05. Thus, the LIW originated in the Rastern Basin, is denser than the resident Western Mediterranean Water. Once in this basin, it settles down at a level (1800-1900 m of depth), that is determined by the relative densities of the waters. The progressive deepening of the LIW along the principal route from the Strait of Sicily to the Tyrrhenian Sea, can be observed in the isotherms, isohalines and isopycnes evolution. In particular, the isopycnes clearly tend to follow the bottom slope (Figure). This process appears to be similar to the Mediterranean Outflow from the Strait of Gibraltar, which was seen to cascade along the Atlantic continental shelf (PRICE *et al.*, 1993).

The estimation of the physical parameters influencing the sinking of the LIW vein, like the density difference between the inflow and the local density, the current intensity, the bottom slope and the bottom friction, permit to give indications on the vein dynamics and on its mixing with the resident water. In particular, an important part of the mixing between the Levantine Intermediate Water and the Tyrrhenian Deep Water seems to happen in this very limited area.



Vertical cross-section of σ_θ from (A) the Sicily Channel to (B) the Tyrrhenian Sea

REFERENCES

PRICE J.F., M. O'NEIL BARINGER, R. G. LUECK, G.C. JOHNSON, I. AMBAR, G. PARRILLA, A. CANTOS, M.A. KENNELLY, T.B. SANFORD, 1993. Mediterranean Outflow Mixing and Dynamics. *Science*, 259: 1277-1282.

KRIVOSHEYA V. G. and I. M. OVCHINNIKOV, 1973. Properties of the geostrophic circulation of the Tyrrhenian sea. *Oceanology*, 13: 996-1002.

THREE-DIMENSIONAL MODEL FOR OIL SPILL SIMULATION

R. RAJAR, M. CETINA, D. ZAGAR,
University of Ljubljana, FAGG, Hajdrihova 28, Ljubljana, Slovenia

In the Gulf of Trieste there are two important oil terminals: Koper (Slovenia) and Trieste (Italy), the last with about 30*10**6 tons of yearly transport. A need for a reliable model appeared to be used as a tool at combating possible oil spills in the gulf. There are several oil spill models on the market, most of them being two-dimensional (2D). But according to our experiences 2D models cannot simulate very accurately the spreading of oil in coastal regions, especially in semi-enclosed gulfs as is the Gulf of Trieste. The main driving force of the circulation in the surface layers - where mainly the oil spill transport and fate processes take place - is the wind. But since the velocity field in the surface layer is usually very different from the depth averaged circulation as obtained by a 2D model, most 2D models take into account the influence of the wind forcing in a simplified way, taking the surface velocity (influencing the oil advection) as 3 to 4 % of the wind speed and a certain drift angle between the wind and current directions (usually between 10 to 17 degrees).

3D models should simulate the HD circulation more accurately, since they take into account non-uniform velocity distribution along the depth, the velocities in the surface layer being the most influenced by the wind. Additionally, the shear diffusion can be taken into account directly by different velocities in the uppermost layers.

Therefore our already developed, applied and verified 3D hydrodynamic (HD) baroclinic model (RAJAR and CETINA, 1991, 1992) was completed with the Transport and Fate (TF) module for oil spill simulation. In the HD module, the advection with the effects of wind, river inflow and thermohaline forcing is included. The TF module is based on the Particle Tracking method and includes mechanical spreading, dispersion, shear diffusion and evaporation. Tidal influence was not taken into account since tidal velocities are of the order of 4 to 8 cm/s, while the wind induced velocities are up to 30 cm/s. Besides the model should be as simple and as user-friendly as possible and the tidal influence demands relatively complex input data for the open boundary conditions.

Two modes are used for practical applications at combating oil spills:

- TACTICAL MODE is developed for a partly pre-prepared and partly real time simulations. Since the model should run on simple PC 486 computers, the HD part of the simulation would take too long simulation time, of the order of 8 hours (numerical grid is 59 x 51 x9). Therefore the HD part of the simulation is pre-prepared for 10 different winds (5 directions by 2 wind velocities). For a real case the velocity field is obtained by interpolation in about one minute. But the TF part of the actual spill is simulated directly for the given location, amount and type of the oil spill in 5 to 10 minutes.
- PROGNOSTIC MODE represents 50 pre-prepared diagrams for 5 wind conditions, 5 locations and 2 oil types. These can be used for a very quick first estimate of the size and of the direction of the oil patches.

Fig. 1 shows the simulation of oil spill by the complete 3D model and by the 2D depth averaged model, where no additional influence of the wind on the surface velocities was accounted for. The differences are essential. A research is going on with the study of the accuracy and applicability of both types of models.

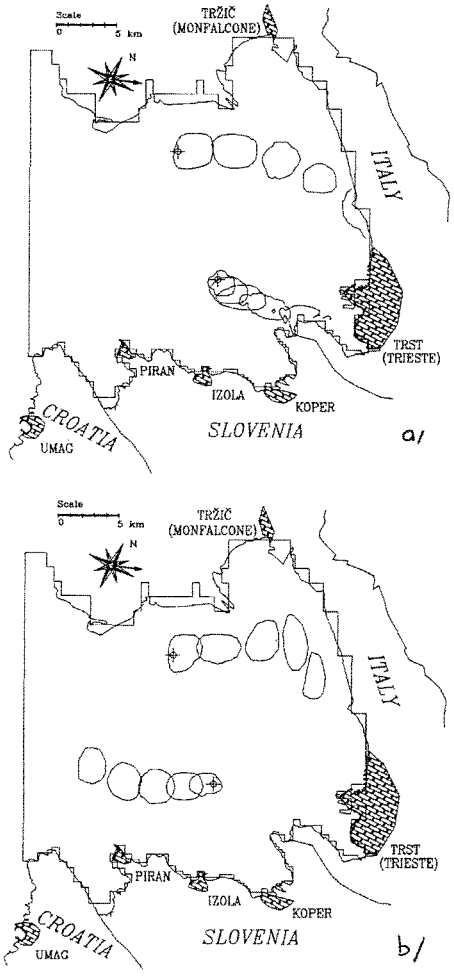


Fig. 1. Simulation of oil spreading for spill at two locations in the Gulf of Trieste with a WSW wind of 8 m/s. Oil slicks in 4, 10, 18, 28 and 40 hours after the spill of 75 tons of diesel fuel.

a) 3D model, surface layer

b) 2D depth averaged model

REFERENCES

RAJAR R. and CETINA M., 1991. Modelling Wind-Induced Circulation and Dispersion in the Northern Adriatic. XXIV Congress of the International Association for Hydraulic Research, Madrid, 9-13/9/1991, Proceedings. 8 pp.

RAJAR R. and CETINA M., 1992. Modelling of Tidal and Wind-Induced Currents and Dispersion of Pollutants in the Northern Adriatic. *Acta Adriatica*, 32 (2) : 785-812.

A MODEL OF WINTER ATMOSPHERIC COOLING AND CONVECTION IN THE LEVANTINE BASIN

B. RAJKOVIC[1], M. KARACA[2], E. ÖZSOY[3] and S. BRENNER[4]

[1] Project Land-3, ICSC World Laboratory, Via Guarnotta 26, 91016 Erice, Italy
[2] Faculty of Mining, Istanbul Technical University, Maslak 80626, Istanbul, Turkey
[3] Inst. of Marine Sciences, Middle East Technical Univ., Erdemli, Içel 33731 Turkey
[4] Israel Oceanogr. and Limnological Research Ltd., Tel Shikmona, Haifa, Israel

Process studies investigating the dynamics and mechanisms of formation of the Intermediate and Deep Water in the Levantine basin are made, based on model simulations driven by initial oceanographic data and high resolution atmospheric forcing. The important effects of the interannual variability of winter atmospheric cooling in the formation process are emphasized by comparing realizations in different sets of conditions in different years.

The Princeton Ocean Model (POM) was used for simulations, initialized with real data. The periods of interest, supported by extensive synoptic data coverage were : (a) October 1986 - March 1987, (b) July 1988 - March 1989, and (c) October 1991 - March 1992, for which initial conditions covering the entire Levantine Basin and verification data at the end of the simulation were available. Persistent open boundary conditions for the semi-enclosed oceanic domain were determined by data extension and melding techniques, using synoptic / climatological data.

The 1987, 1989 and 1992 winters are characterized with massive LIW formation in the region. In addition, Deep Water was formed in the extreme winters of 1987 and 1992. The specific atmospheric and oceanic states leading to such differences are compared between these two cases.

A STUDY OF WATER CIRCULATION ALONG THE EGYPTIAN MEDITERRANEAN COAST USING A THREE DIMENSIONAL NUMERICAL MODEL

M. A SAID[1] an B. RAJKOVIC[2]

[1] National institute of Oceanography and Fisheries, Kayet Bey, Alexandria, Egypt
[2] Land-3 Project, World laboratory, Erice, Italy

The Egyptian Mediterranean coast lies between longitudes 25°30'E and 34°E and extends northward to latitude of 33°N. Its water volume is 224 801,54 km^3 and it has a surface area about 154 840 km^2. Striking feature of this area are the presence of different water masses which converage and mix. The Princeton Ocean Model (POM) which makes use of a curvilinear orthogonal grid and of a sigma-coordinate system was used to study the general circulation of the Egyptian Mediterranean waters. The model was described in detail by BLUMBERG and MELLOR (1987).

The model bathymetry was obtained from the bilinear interpolation of the depth data into the model grid. The model grid contains 35 x 11 points with a resolution ranges from 22 to 27 km (fig. 1). The model has three open boundaries to the West, East and North.

The model has been initialized with the temperature and salinity seasonal averages prepared by the National Institute of Oceanography and Fisheries (NIOF) at the following 22 depth layers : 0, 10, 20, 30, 50, 75, 100, 125, 150, 200, 250, 300, 400, 500, 600, 800, 1000, 1200, 1500, 2000, 2500 and 3000 m depth. The average values of temperature and salinity were mapped on a 1/2° x 1/2°. The monthly heat flux were computed on a 1/2° x 1/2° grid.

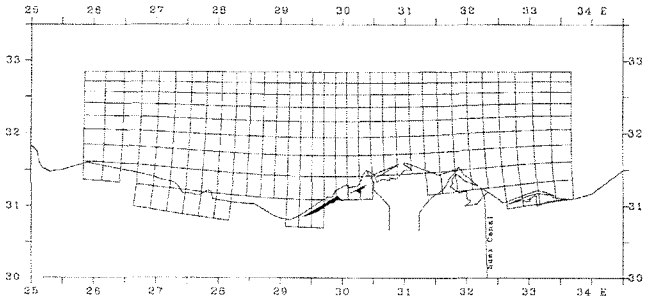


Fig. 1. The model grid.

Three numerical experiments are suggested to be performed using different kinds of surface forcings. In experiment-1, we examine the effects of seasonal water temperature and salinity fields only, by eliminating any seasonality in the surface heat and salinity fluxes and the wind stress forcing. The surface current velocity fields for the winter and summer seasons are shown in figure 2 and 3, respectively.

The surface circulation of the Egyptian waters is dominated by the easterly low along the coast and by the Mersa Matruh anticyclonic circulation in the western part of the area. In the present work, Mersa Matruh gyre exhibits a strong winter to summer variability reversing from anticyclonic to cyclonic.

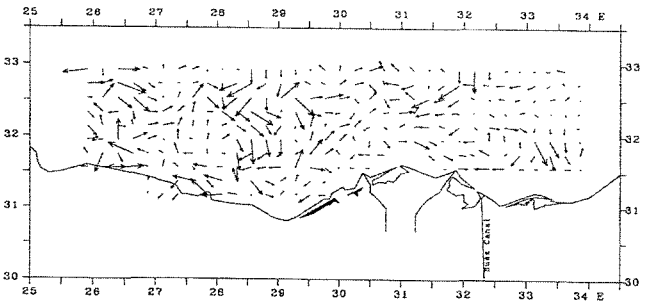


Fig. 2. Experiment-1 : Current velocity at the surface during the winter

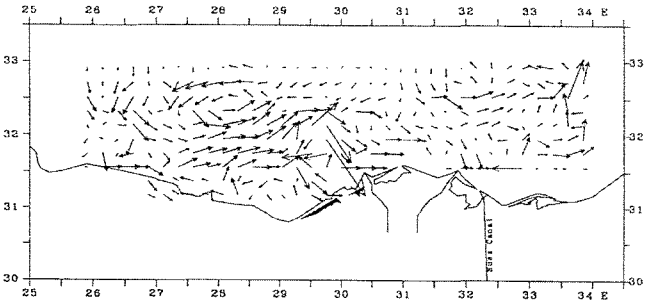


Figure 3. Experiment-1 :Current velocity at the surface during the summer

REFERENCES

BLUMBERG A. F., MELLOR G. L., 1987. A descritpion of three-dimensional coastal ocean circulation model. N. S. Heaps ed. AGU. Washington D.C. *Coastal Estuarine Sci.*, 4 : 1-16.

CIRCULATION PATTERN OF THE EGYPTIAN MEDITERRANEAN WATERS DURING WINTER AND SUMMER SEASONS

M. A. SAID[1] and F. M. EID[2]

[1] National institute of Oceanography and Fisheries, Kayet Bey, Alexandria, Egypt
[2] Oceanography department, Faculty of Science, University of Alexandria, Egypt

The water circulation of the Egyptian Mediterranean waters was computed during winter and summer seasons using the dynamic method. The reference level was raken at the 1000 db surface. In the shallow parts of the area where the depths were less than the depth of the reference level, Groen's method was applied. The dynamic height anomaly differences between stations were used for computing the geostrophic current speed and direction at the centre of each grid.

The oceanographic data used were selected from several expeditions carried out by Egypt and different countries for the last 27 years (1959-1986). Water temperature and salinity data have been taken from 162 hydrographic stations in winter and 152 in summer. The winter was represented by the data collected during the period from January to March, while the summer was determined by the period from July to September. The average values of temperature and salinity of these data were computed, using the optimum interpolation of the correlation algorithm, for stations distributed in a regular grid half degree latitude by half degree longitude for the both seasons.

Charts of surface circulation constructed for the winter and summer seasons areshown in figure 1. The surface circulation is dominated by the Atlantic water inflow along the North African coast and by two major gyres. The Mersa Matruh anticyclonic gyre in the western part of the Egyptian coast, was observed and discussed in details by ÖZSOY *et al.* (1989).

In the eastern side of the study area, off El-Arish city, the circulation is cyclonic in winter. This circulation exhibits a strong winter to summer variability, reversing from cyclonic to anticyclonic. In the scientific literature there is no evidence of the existence of such a gyre. Consequently, we will call it El-Arish gyre.

Dynamic topography for the 50 and 100 m levels reveals the same general pattern of those observed at the surface for the winter. While in summer, El-Arish gyre is completely disappeared. At the deeper levels (250 and 500 m), small eddies appear within the major gyres as well as between them. The Mersa Matruh gyre split into multiple centres. The eddy centres are shifted horizontally with depth. El-Arish gyre could still be identified only in winter and consists of two small centres.

The geostrophic current velocity at the edges of Mersa Matruh gyre varies between 12,5 and 29,1 cm/sec. in winter and between 6,5 and 13,1 cm/sec. in summer. The current velocity reaches its maximum values (~ 40 cm/sec.) at El-Arish gyre in winter. The current velocity at the two gyres decreases with increasing depth. The North African current affects the surface waters down to a depth of 100 m, and that its mean velocity varies between 6 and 38 cm/sec.

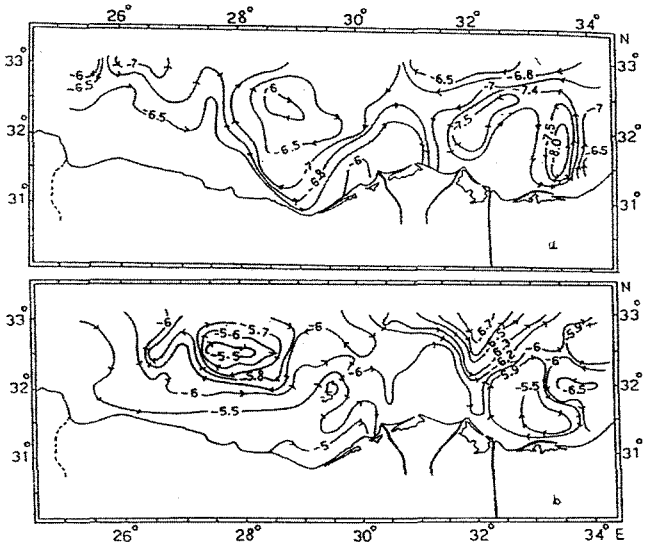


Figure 1. Geostrophic circulation of Egyptian Mediterranean surface waters during (a) winter and (b) summer seasons.

REFERENCES

ÖZSOY E., HECHT A., UNLUATA U., 1989. Circulation and hydrography of the Levantine basin : results of POEM coordinated experiment 1985/86. *Prog. Oceanogr.*, 22 : 125 - 170.

OBSERVATION OF MESOSCALE STRUCTURES IN THE ALBORAN SEA WITH ERS-1 SAR IMAGES AND DATA FROM ACOUSTIC DOPPLER CURRENT PROFILER (ADCP) AND CTD

Bernardo SHIRASAGO, Elisa G. GORRIZ and Jordi FONT

Institut de Ciències del Mar CSIC, P. Joan de Borbo s/n, 08039 Barcelona, Spain

The observation of surface mesoscale structures in the Alboran Sea has been addressed by analyzing Synthetic Aperture Radar (SAR) images from the ERS-1 satellite and ship data. The latter include Acoustic Doppler Current Profiler (ADCP) and Temperature Conductivity and Depth (CTD) data.

The Alboran Sea is the first Mediterranean basin encountered by the Atlantic Water (AW) which flows inward through the Strait of Gibraltar. Many experiments have shown a high variability of the AW circulation, both in space and time (GASCARD and RICHEZ, 1985). One of the most important features formed in the western basin of this sea is a big quasi-permanent anticyclonic gyre (DONDE VA? GROUP, 1984; LA VIOLETTE, 1986). Numerical studies have examined the existence of this gyre and indicate it might be related to the non-linear density advection off the Strait of Gibraltar (WANG, 1987).

At the eastern basin less information is available, although several studies have shown that a second anticyclonic gyre or an eastward current along the African coast is present (LA VIOLETTE, 1990; VIUDEZ *et al.*, 1994). Typical diameter of these twi gyres as near 100 km.

The study was carried out with 26 SAR images SAR. FDC format that cover the Alboran sea from September 12th to October 14th, 1992. The ship data were obtained during an oceanographic cruise (FE92), performed on the Spanish R/V "Garcia del Cid"from September 17th to October 10th, 1992 and that included 134 stations. CTD casts in each station and continuous ADCP and surface T-S (Temperature-Salinity) alongtrack measurements were recorded. SAR images were reduced to a 512 X 512 pixel format and geolocated using the points supplied by ESA in each tape by means of an image processing system GEOJARS. This procedure was done in order to overlay the ADCP vectors on the images. The ADCP data were averaged every thirty minutes and maximum current velocities near 100 cm/s were obtained in some places.

Results in the comparison between SAR, ADCP and CTD data have shown a high correlation in the detection of mesoscale structures, especially the Western Anticyclonic Gyre, the baroclinic jet associated to both gyres and the eastward Algerian Current exiting the Alboran Sea. It is important to mention that some other structures, smaller in dimension as eddies and internal waves packets, are present in the SAR images.

This study is part of EUROMODEL MAST II project No. MAS2-CT93-0066 and ESA/ERS-1 AO Project E1 "Evaluation of ERS-1 Microwave Sensors Capability in the Study of Oceanic Fronts".

REFERENCES

DONDE VA? GROUP, 1984. ¿Donde Va?, An oceanographic experiment in the Alboran Sea. The oceanographic report, Eos Trans. AGU, 65(36) : 682-683

GASCARD J.-C. and Richez C., 1985. Water masses and circulation in the western Alboran Sea and in the strait of Gibraltar. *Prog. Oceanogr.*, 15 : 157-217.

LA VIOLETTE P. E., 1986. Short term measurements of surface currents associated with the Alboran Sea gyre during ¿Donde Va? *J. Phys Oceanogr.*, 16 : 262-279.

LA VIOLETTE P. E., 1990. The Western Mediterranean Circulation Experiment (WMCE). Introduction. J. *Geophys. Res.*, 95, (C2) : 1511-1514.

VIUDEZ A., TINTORE J., HANEY R. L., 1994. Three-dimensional structure of the two anticyclonic gyres in the Alboran Sea. *J. Phys. Oceanogr.* (accepted).

WANG D. P., 1987. The strait surface outflow, *J. Geophys. Res.*, 92 : 10807-10825.

SEA LEVEL VARIATIONS IN RESPONSE TO WATER BUDGETS AND BAROMETRIC PRESSURE EFFECTS IN THE BLACK SEA

Halil I. SUR[1], Yuri GORYACHKIN[2], Mohammed A. LATIF[1] and Emin ÖZSOY[1]

[1] Institute of Marine Sciences, Middle East Technical University, P.K. 28,Erdemli, Içel 33731 Turkey

[2] Ukrainian Academy of Sciences, Marine Hydrophysical Institute 2, Kapitanskaya Str., Sevastopol 33500 Crimea, Ukraine

Long-term sea-level records from various stations in the Black sea (47 stations along the northern coast, 4 along the western coast, 1 on the southern coast), 2 in the Bosphorus, 1 in the Marmara sea and 3 along the Aegean / Mediterranean coast are studied to determine the seasonal and interannual dependence of sea-level variations in the Black sea, and its relationship with the neighboring seas. The relationship between sea-level and barometric pressure effects are investigated. Similarly, freshwater influx from rivers, evaporation and precipitation data are used to assess the variability in water budgets, and these are linked to the Bosphorus exchange flows and sea-level variations.

Spectral analyses show the time-scales in the sea-level, barometric pressure and the elements of the water budget are linked from seasonal to interannual periods. Shorter period variability in sea-level is related to storm surges and dynamical processes.

The hydraulically controlled flow in the Bosphorus plays a determining role in the sea-level variations. Barometric pressure differences between the Black sea and the adjoining seas are also very important in driving the exchange flows and the sea-level response.

O

SURFACE LAYER CURRENTS AND MESOSCALE THERMAL PATTERNS IN THE BLACK BLACK SEA DURING APRIL 1993

Halil I. SUR[1], Yuri P. I. LYIN[2], Emin OZSOY[1] and Vitaly I. IVANOV[2]

[1] Inst. of Marine Sciences, Middle East Technical Univ., Erdemli, Içel, 33731, Turkey
[2] Marine Hydrophysical Inst., Ukrainian Academy of Sciences, Sevastopol, Ukraine

CTD and ADCP measurements carried out in April 1993 are used to describe the circulation in the western Black Sea. Figure 1a shows horizontal current vector distributions at 10 m level. Maximum velocities measured at stations did not exceed 45-50 cm/s, while measurements reached 70 cm/s during ship was under way. Large-scale structures coinciding to the Rim Current west of the Crimean peninsula and along the Turkish coast are well identified. Weaker flows are observed on the North-West shelf (10-15 cm/s), and in central regions of the sea (maximum ≈20 cm/s).

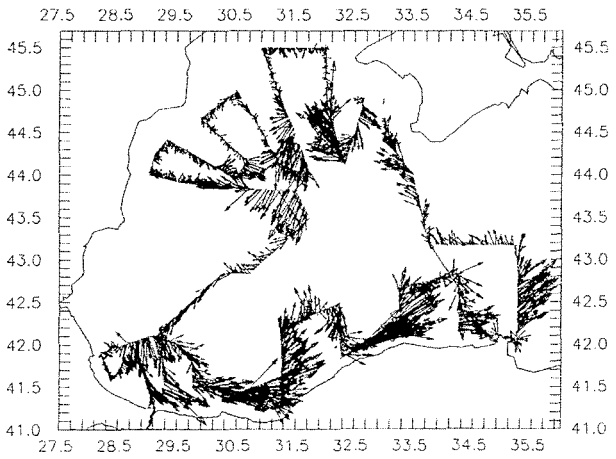
The nearest cloud free AVHRR scene to the cruise obtained in April 19, 1994 (Figure 1b) clearly shows the meandering band of warm water corresponding to the Rim Current west of Sevastopol. To the South, along 44.2°N the cold water area is formed possibly by flow divergence and separates into two branches. Amplitude of cold anomaly is -1.2 °C at the foot of northern current branch of cyclonic meander west of the Crimea. To the west of this meander, the anticyclonic Sevastopol eddy has a diameter of 55 km (centered at 44.5°N, 32.1°E). Further to the West there is another cyclonic meander separating the Sevastopol eddy from the next anticyclonic eddy centered at 43.3°N, 30.5°E.

The North-West shelf is colder (1.5-2.0°C) than the Rim Current water along the continental slope. Near the western shore, the Danube waters are well differentiated, since they are warmer than shelf water by about 1.5°C. The Danube waters enter the sea from three clearly distinguished three river mouths (Kilija, Sulina and St.George) and spread in a narrow band along the coast towards the South, forming the off-shore anticyclonic eddy south of Cape St.George. The cold shelf water zone connected with north-eastern shelf is seen in between the near-shore jet and Rim Current flowing along the shelf edge.

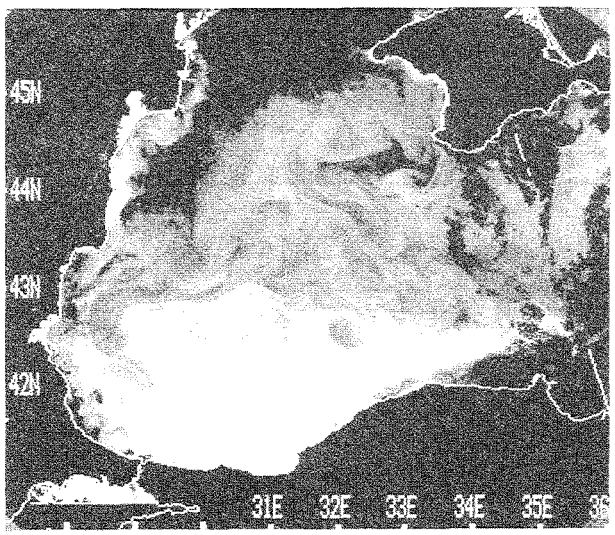
Along the southern coast, the Rim Current is distinguished by maximum temperature. An anticyclonic eddy north of this jet (centered at 42.5°N, 31.7°E) a diameter of ≈40km and temperature difference of ≈6°C between its center and periphery. The cold eddy was possibly generated by the instability of the Rim Current. Numerous frontal boundaries separating bands of water advected eastwards are observed in the region.

Very good correspondence exists between the currents and thermal structures. The velocity maxima coincide with the frontal regions. The combined use of ADCP and satellite data provides a better description of the mesoscale circulation as compared to the individual sets of data.

Figure 1. (a) ADCP current measurements at 10 m depth, ...



...and (b) infrared AVHRR images in April 1993.

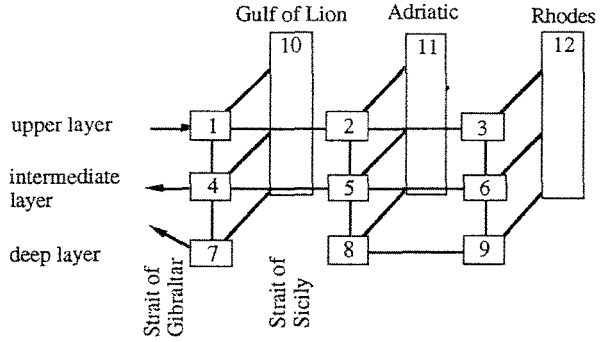


PUTTING WATER MASSES, CIRCULATION AND SURFACE FLUXES TOGETHER FOR THE MEDITERRANEAN : A BOX-MODEL STUDY

Benyang TANG[1], Alex LASCARATOS[2] and Andrew J. WEAVER[1]

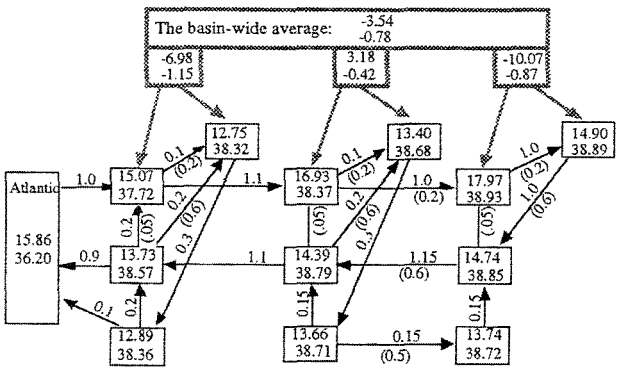
[1] School of Earth and Ocean Sciences, Univ. of Victoria, B. C. V8W 2Y2, Canada
[2] Univ. of Athens, Dept. of Applied Physics, 33 Ippocratous Str., 10680 Athens, Greece

Water masses, circulation and air-sea interactions are three important components of the Mediterranean system. The estimates of these three components should be consistent in terms of heat and salt balance in differents sectors of the Mediterranean basin. In this study, we put the water masses, circulation and surface fluxes together in a box model to examin the heat and the salt balance. We estimates the latter two by asking the question : What circulation and surface fluxes give the Mediterranean temperature and salinity distributions ?



The 12-box model is shown in fig. 1. The southern 9 boxes represent the major body of the Mediterranean seea which is divided into three subbasins and into three layers, their thickness being 150 m, 450 m and about 1 500 m, respectively. Each of the northern three boxes represent the whole water column of the small region where deep or intermediate water is formed. Boxes are connected by horizontal and verticals flows and mixing. Surface heat and fresh water fluxes are applied to the six surface boxes. Atlantic water enters into box 1 and the Gibraltar intermediate and deep water outflows are from box 4 and 7, respectively. The average temperature and salinity for each of the nine southern boxes is calculated from the Levitus'data. The heat balance of the box model can be written as A x = b, where A depends on the flow and mixing rates, x is a vector of temperature for the 12 boxes, and b depends on the surface and Gibraltar heat flux. The temperature can be solved as $x = A^{-1}b$. Then the difference between the model temperature x of boxes 1-9 and the Levitus' is minimized by adjusting the flow and mixing rates and the surface heat flux. The flow and mixing rates are adjusted manually, guided by estimates from previous studies, and the surface heat is then determined by a linear optimization aquation. A similear procedure is followed to minimize the difference in salinity.

After many tries of flow and mixing patterns, the solution shown in figure 2 was found to give a good match of water masses to Levitus'; the average differences between the model and the Levitus' are 0,15°C in temperature and 0,06‰ in salinity. In figure 2, the two numbers in each ocean box are temperature and salinity. The number above the line is the flow rate in Sv, the number below the line and enclosed in parentheses is the mixing rate in Sv. The two numbers in a gray line box are the heat and fresh water fluxes into the ocean, in W/m^2 and m/year respectively. The flow and mixing rates and the surface fluxes that produce the fit in fig. 2 are in good agreement with other estimates in general. A major problem in reproducing the Levitus'water masses is that the intermediate water in the western Mediterranean (box 4) cannot be cooled enough; box 4's temperature is 13,73°C, 0,4° higher than the Levitus. The warmer box 4 leads to a smaller temperature difference between the inflow and outflow at the strait of Gibraltar, thus a smaller basin-wide heat loss (3,5 W/m^2) than other estimates. In fig. 2, box 4 is cooled mainly by the 0,2 Sv upwelling. What else can also cool the western Mediterranean intermediate water ? When we changed the horizontal mixing between boxes 4 and 10 from the backgroung mixing of 0,6 Sv to 3 Sv, representing a 2-3 intermediate water production in the western Mediterranean, box 4 is cooled to the Levitus'value, and the overall fit becomes much better, the average difference between the model and the Levitus being reduced to 0,05°C and 0,3‰. A plausible argument for this large amount of intermediate water formation in that, in a less severe winter storm, the cooling in Gulf of Lions forms water that is no dense enough to penetrate to the deep layer but instead spreads to the intermediate layer. Increasing the deep water formation in Gulf of Lions and enhancing the mixing with deep water are other mechanisms to cool box 4. The basin wide average heat loss in fig. 2 is 3,5 W/m^2, set by the Gibraltar heat flux. unlike the other estimates, the distribution among the three subbasins is unevent large heat losses in the western and eastern subbasins and a heat gain in the central subbbasin. This flux distribution is determined by the circulation and ocean temprature. As the 1,1 Sv of water flows from box 1 to 2, the temperature jumps to 2°C, requiring a large amount of surface heating in box 2, while the 1 Sv intermediate water production in box 12 demands substantial surface cooling.



WATER MASS SPREADING PATTERNS AND LARGE-SCALE CIRCULATION OF THE EASTERN MEDITERRANEAN SEA INFERRED FROM NEUTRAL SURFACE ANALYSIS

Athanasios J. THEODOROU

Department of Agriculture, Crop and Animal Production, University of Thessaly
Pedion Areos, Volos, 383 34, Greece

The general features of the water masses and their circulation patterns in the Eastern Mediterranean have been known for some time - see, *inter alia*, EL-GINDY and EL-DIN (1986), MALANOTTE-RIZZOLLI and HECHT (1988), OZSOY, HECHT and UNLUATA (1989). The aim of the present study is to infer the quantitative circulation patterns of the Levantine Intermediate Water (LIW) and of the Deep Water (DW) within the Eastern Mediterranean Sea via neutral surface analysis based techniques.

To this end, first the idea of a "perfect" neutral surface is re-explored and some possibilities for approximating the latter are comparatively examined, leading to the introduction of a new modified version of the "central-reference-pressure" (THEODOROU, 1991) approach; the latter in conjunction with CTD data collected within the framework of POEM experiments supported with historical hydrographic data is used to obtain a number of neutral surfaces on which the spreading of LIW and DW will be examined.

Neutral Surface Analysis. The salinity distribution on those neutral surfaces was qualitatively examined and detailed patterns of the spreading of LIW and of the DW within the eastern Mediterranean were inferred. The topographies of the neutral surfaces were found to follow closely the configuration of the bottom bathymetry. The isohalines on all neutral surfaces were approximately parallel to the depth contours of the respective topographies, and the salinity maxima persisted for hundred of km without being eroded. Vertical mixing was important in the source regions of the two main water masses, whilst all features of the three dimensional salinity distribution could be accounted for in terms of lateral mixing and flow.

Water Mass Analysis. Plots of oxygen versus salinity on the neutral surfaces enabled the identification of the characteristics of the source waters and also of the number of water types involved in the mixing. Within this framework a variant of the technique of "mixing triangles" was employed and quantitative spreading patterns of the unmodified LIW on a number of neutral surfaces were obtained; these results were coherent with the inferences from the analysis of the salinity distribution on the same neutral surfaces

Dynamic Inferences. Using "composite sectional diagrams" dynamic inferences were made; these inferences in conjunction with the associated thermohaline alternations provided a description of the modification patterns of the LIW and of DW along their respective courses. In the same context, occurrence and development of mesoscale "disturbances" and loci of possible cross-isopycnal mixing were identified.

Geostrophic Fluxes. The qualitative picture of the flow field, obtained from the configuration of the neutral surfaces, under the assumption of geostrophy, was quantitatively examined by the computation of geostrophic currents and transports. The latter were further analysed, in conjunction with the mixing triangles defined within the study area, and numerical estimates of the relative proportion of the main water masses were obtained.

Circulation Patterns. The results were combined within the constraint of mass balance and in conjunction with the spreading patterns deduced, produced detailed quantitative patterns of the large-scale time mean flow of the intermediate and deep waters of the Eastern Mediterranean.

REFERENCES

EL-GINDY A. A. H and EL-DIN S. H., 1986. Water masses and circulation patterns in the deep layer of the Eastern Mediterranean. *Oceanologica Acta*, 9, (3) : 239-248.

MALANOTTE-RIZZOLI P. and HECHT A., 1988. Large-scale properties of the Easterb Mediterranean : a review. *Oceanologica Acta*, 11, (4) : 323-336.

OZSOY E., HECHT A. and UNLUATA U., 1989. Circulation and Hydrography of the Levantine Basin. Results of POEM coordinated experiments 1985-1986. *Prog. Oceanog.* 22 : 125-170.

THEODOUROU A. J., 1991. Some considerations on neutral surface analysis. *Ocean. Acta*, 14(3) : 205-222.

ONE YEAR OF HYDROBIOCHEMICAL OBSERVATION IN A TRANSECT IN FRONT OF SENIGALLIA (NORTH ADRIATIC SEA)

TOTTI C., ARTEGIANI A., DELLA SALA K., PASCHINI E. and A. RUSSO

Istituto Ricerche sulla Pesca Marittima (IRPEM), CNR, Ancona, Italia

In the framework of ELNA project (Eutrophic limits of the Northern Adriatic Sea), a monthly cruise is conducted from February 1993 in a transect in front of Senigallia, in order to monitoring the outflow of the North Adriatic. Stations sampled during each cruise (st. 0, st. 1, st. 2, st. 3, st. 4, st. 5) are located at 0.5, 1.2, 3, 6, 10, 15 NM from the coast. At each station sampling is done with CTD profiler, coupled with a Rosette multisampler, for the measure of temperature, conductivity, dissolved oxygen and fluorescence. Samples for nutrient salts, chlorophylls and phytoplankton determination are taken at significant depths checked on the basis of the CTD profile.

The thermohaline water structure exhibits a well defined seasonal evolution (fig.1). A coastal front present in the winter period confines along the coast the run-off of the northern Adriatic and local rivers, with very low value of salinity and high concentration of total inorganic nitrogen (st. 0, 1 and 2). In the deeper layer of the offshore part of the section it is possible to see the influence of the North Adriatic bottom water.

The spring period is characterised by a surface (0-10 mt.) thermohaline vertical gradient present over all the section. Two principal factors determine this configuration : the air-sea heat exchange begins to be positive for the sea and the river run-off has his maximum in spring.

In summer a two layers system dominates the section : a surface well mixed layer (15 mt. depth) with T> 23°C and S>38 PSU, and a deep layer, from 30 m to the bottom with T<14°C and S>38.0 PSU. Between the two layers a sharp thermocline is developed.

In fall it was registered a situation similar to spring: a thermohaline vertical gradient is present in the first 10 mt., but with a reversal thermal gradient, that is cold water at the surface, and warm water at the deeper layers. The stability conditions are preserved by the low values of salinity.

In general the nutrients are distributed with a negative gradient from coast to offshore. The nitrate fraction dominates the total nitrogen. A maximum in nitrogen concentration is detected in spring due to increasing runoff. A second strong peak was detected in December, during a period of low phytoplankton density. Good correspondence is found between nitrate trend and phytoplankton density trend, with a typical phase-difference between the two time series. Phosphorus, as orthophosphate, is present in very low concentration, often under the detection limit of analytical method. Phosphorous source for phytoplanktonic metabolism must necessarily be supported by the more consistent organic fraction.

Phytoplankton annual cycle is showed in fig.2. Quantitative data for phytoplankton cell density are expressed as cells/ml; no biomass measurements by now are done. Average values are integrated on water column. Abundance trend shows a maximum value in 2 stations onshore (over 9000 cells/ml) in correspondence of winter-spring diatom bloom, due to *Skeletonema costatum*, a typical winter blooming species in the Adriatic sea. Bloom started in February, extended from st.0 to st. 2 and touches maximum values in March. Next peak in phytoplankton trend was registered during May, and corresponds to an increase of phytoflagellate component that represented over 80% of total abundance. Then another peak appears in correspondence of autumnal season, and was again due to diatoms (*Chaetoceros radians* with an high diatom species diversity). Annual cycle ends in January again with a maximum; phytocenosis was now dominated by phytoflagellate component but also diatoms were well represented with *Asterionella glacialis* and *Skeletonema costatum* association.

For total values and for all the groups except Coccolithophorids, decreasing gradient from coast to offshore was regularly found. Stations from 6 nM offshore always seem to be scarcely productive, in terms of phytoplanktonic activity, and are considered representative of an olygotrophic system. Good correspondence was found between chlorophyll data and phytoplankton abundance, for chlorophyll a as well as chlorophyll c.

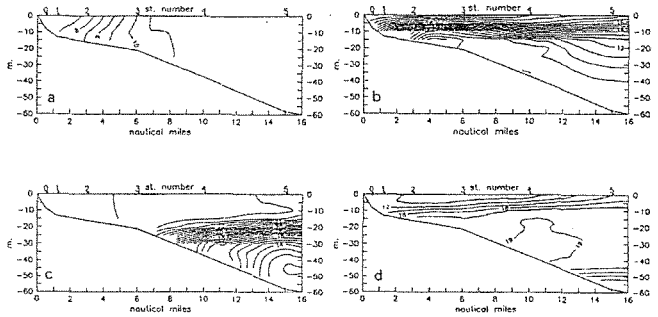


Fig.1. Temperature distribution on the section during winter (a), spring (b), summer (c) and fall (d)

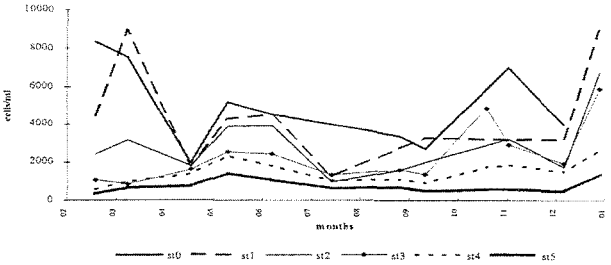


Fig.2. Phytoplankton abundances in cells/ml - Average integrated on water column

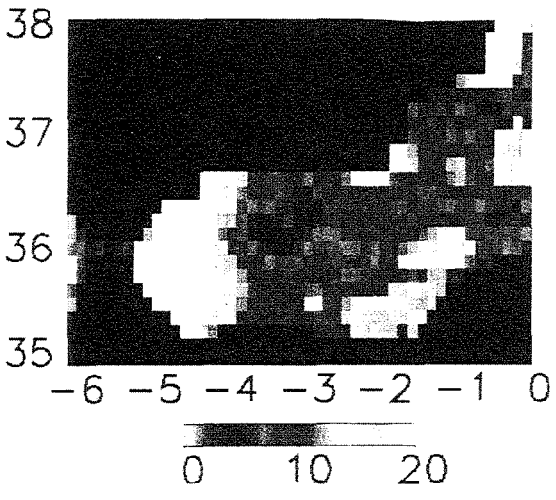
LONG TERM TEMPORAL EVOLUTION OF THE SURFACE LAYER CIRCULATION IN THE ALBORAN SEAOBSERVED FROM THE ERS-1 ALTIMETER

Jorge VAZQUEZ[1] and Jordi FONT[2]

[1] Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA
[2] Institut de Ciències del Mar CSIC, Barcelona, Spain

EUROMODEL is one of the MAST II/MTP Core Sub-projects. Its main objective is to describe, understand and simulate the circulation in the western Mediterranean sea with particular emphasis on the seasonal and mesoscale variability. One key region is the Alboran sea, where the incoming jet of Atlantic water forms a meandering current with one or two gyres. The Alboran Sea dynamics has been the object of several EUROMODEL studies, from both the numerical and experimental aspects (e.g. SPEICH, 1992; VIUDEZ *et al.*, 1994). "Evaluation of ERS-1 microwave sensors capability in the study of oceanic fronts" is a project selected by the European Space Agency (ERS-1 AO E1) that aims at identifying surface mesoscale structures in the western Mediterranean by ERS-1 altimeter and SAR. In this context altimeter data have been used to study the long-term variability of the sea surface topography in the Alboran sea. This variability provides information on the temporal evolution of the regional circulation, that appears to be complex with occasional disappearance of one of the gyres (mainly the eastern) and intense mesoscale motion along the meandering jet.

Data from ERS-1 altimeter have been extracted in the region 35°N to 38°N and 6°W to 0°. Atmospheric corrections, such as the wet and dry troposphere, were applied to the data extracted in the area along with the removal of the Rapp geoid, and the orbit error by means of removing a linear tilt and biass in the along-track direction over the Mediterranean. Tides were also removed using the CANCEIL *et al.* (1994) tide model for the Mediterranean. The along-track data were interpolated to a regular grid in space-time using a successive correction scheme whereby the space-time scales for each successive iteration converge. Maps of residual sea level were then created at regularly spaced intervals of 10 days with a 35-day e-folding time scale applied in the spatial domain to include an entire repeat. The obtained values, with maxima of 20-30 cm, are on the order of oceanographic variability. To extract the spatially coherent signal a set of Complex Empirical Orthogonal Functions (CEOF) were derived from the 75 10-day maps from Feb. 1992 - Jan. 1994. Unlike real EOFs the complex CEOFs give both amplitude and phase information since the eigenvectors of the spatial covariance matrix are now complex. The slope of the temporal phase versus time is then the instantaneous frequency of the propagating wave (VAZQUEZ, 1993). The first 3 CEOF modes explain 71% of the total variance. CEOF 1 accounts for 45% of the variance and is likely associated with changes in the incoming jet in Gibraltar or even the western anticyclonic gyre. It has two maxima out of phase between 5° and 4° W, indicating that if the circulation associated with the southern maximum is anticyclonic (gyre), the circulation of the northern maximum is cyclonic. This scenario is consistent with model results and with observations of cyclonic eddies north of the main anticyclonic gyre (LA VIOLETTE, 1984; TINTORÉ *et al.*, 1991). The second CEOF (17 % of the variance) appears to be associated with the western anticyclonic gyre, and in addition highs can be seen in areas of the Almeria-Oran front and the formation of the Algerian Current. There is a 180° phase difference across the front indicative of the possible slope in sea level. The spatial structure of CEOF 3 (9% of the variance) is more complex and seems clearly associated with changes in the structure of both gyres. The spatial phase of the western anticyclonic gyre indicates little or no propagation but its formation represents a quasi-stationary pattern. However the phase contours for the maximum located at the position of the eastern gyre change across the maximum, indicating a propagation along the African coast.



The figure shows the sea surface height variability for the two years of data. The maximum values (in centimeters) are found at the western boundary of the basin, close to the Strait of Gibraltar.

This study is a contribution to EUROMODEL (MAS2-CT92-0066). ESA provided ERS-1 data through an agreement with CSIC. The Catalonia Supercomputing Centre (CESCA) provided Cray Y-MP cpu time. In 1993 J. Vazquez was a visiting scientist at ICM Barcelona funded by the Spanish Ministry of Education and Science (DGICYT SB92-A33710418).

REFERENCES

CANCEIL P., AGELOU P., VINCENT P., 1994. Barotropic tides in the Mediterranean Sea using a finite element model. *J. Geophys. Res.* (in press).
LA VIOLETTE P. E., 1984. The advection of submesoscale thermal features in the Alboran Sea gyre. *J. Phys. Oceanogr.*, 14 : 550-565.
SPEICH S., 1992. Etude du forçage de la circulation océanique par les détroits : cas de la mer d'Alboran. PhD Thesis, Univ. Paris VI, France.
TINTORE J., GOMIS D., ALONSO S., PARRILLA G., 1991. Mesoscale dynamics and vertical motion in the Alboran Sea. *J. Phys. Oceanogr.*, 21: 811-823.
VAZQUEZ J., 1993. Observations on the long-period variability of the Gulf Stream downstream of Cape Hatteras, *J. Geophys. Res.*, 98 : 20,133-20,147.
VIUDEZ A., TINTORE J., HANEY R.L., 1994. Three dimensional structure of the two anticyclonic gyres in the Alboran sea. *J. Phys. Oceanogr.* (accepted).

COURBES DU COURANT LIGURO-PROVENÇAL MARQUÉES PAR LA PRÉSENCE DE GRANDS CÉTACÉS

CAMPAGNES ARGOCET DES N/O DU CNRS INSU**

D. VIALE*

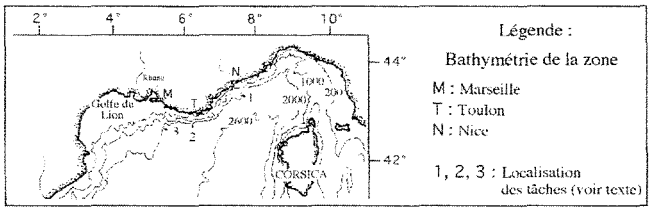
*et collaborateurs, Univ. de Corse, 20250 CORTE; CNRS AI 034915, URA 877, France

La partie du courant ligure étudiée ici est comprise entre le Cap de Mele et le Cap de Creux. Dans le cadre du programme Western Mediterranean Circulation Experiment une concomittance des grands cétacés, baleines et cachalots, avec de fortes biomasses détectées acoustiquement a été démontrée en liaison avec la circulation méditerranéenne (VIALE & FRONTIER, 1994). Le suivi d'une baleine par satellite en 1991 a permis de voir l'intérêt qu'elle porte au courant cyclonique. Cependant, le temps qu'elle passe sur certains tronçons de ce courant en révèle l'intérêt du point de vue alimentaire ; la production sur le bord de ce courant apparaît discontinue. Les grands cétacés peuvent donc servir de descripteurs des zones d'enrichissement : nous le montrons ici.

Des observations sont réalisées suivant des trajets qui recoupent systématiquement les zones en taches où des observations ont été faites antérieurement ; des rubans d'observation sont également faits systématiquement dans les zones vides entre les taches. Les moyens mis en oeuvre et décrits par ailleurs (VIALE, 1991) sont l'observation *de visu* pour détecter la mégafaune de surface et une détection acoustique continue et enregistrée. La campagne d'avril 1994 nous a permis d'utiliser en outre une cartographie informatisée et visualisée sur écran, en connexion avec le système d'orientation du navire. Il est possible de localiser les observations de baleines, y compris les anciennes et de visualiser le trajet parcouru. Ceci fournit une vision synthétique et synchrone permettant de se situer par rapport à la côte, par rapport au courant, au front éventuel et à la bathymétrie. Auparavant une telle synthèse était faite après la campagne. Parallèlement, le repérage des fronts thermiques de surface est fourni par le Centre de Météorologie Spatiale de Lannion. Un échosondeur à enregistrement sur papier permet la conservation des informations sur la richesse des biomasses dans la colonne d'eau sous notre trajet. En avril 1994, une répétition des mêmes trajets (3 fois) a conduit à une synthèse de ces données et nous a permis de comprendre les différences entre les "taches" et les vides entre les taches.

En cumulant les observations de baleines au cours de toutes les campagnes ARGOCET (de 1986 à 1994) ayant étudié cette portion du courant ligure, trois taches d'observations fréquentes apparaissent, intercalées par des tronçons vides. En avril 94, la répétition des mêmes trajets a permis de confirmer les observations précedentes.

De l'Est vers l'Ouest, la première tache est centrée autour d'un point à 25 milles dans l'axe 133° du Cap Ferrat. Elle correspond à un virage du courant ligure vers le large, du fait de la forme du talus. La deuxième tache est centrée sur la zone située de 16 à 22 milles de la pointe est de l'île du Levant et correspond également à une incurvation du courant ligure vers le large. Entre ces deux taches, les nombreux passages en vigie au cours des campagnes citées n'ont pas fourni d'observation de baleines. La troisième tache est localisée contre le talus du Golfe de Lion à 45 milles au sud de Marseille ; c'est de loin la tache la plus importante. Elle correspond au virage du courant le long du talus qui entraîne l'eau de surface vers le large, compensée par un effet d'upwelling. Une vérification précise au cours de cette campagne a limité à l'est, la zone de vide entre la seconde et la troisième tache : c'est une radiale à 155° de Toulon.



Dans une logique circulaire lors de nos campagnes à la mer, nous interrogeons *a priori* nos collègues océanographes pour connaître leurs observations les plus récentes pour nous permettre de localiser hypothétiquement les bords du courant liguro-provençal où nous allons chercher des baleines à l'oeil nu en surface ; en retour, leur localisation, quand on les trouve, nous renseigne sur les positions des segments productifs de ce courant. Dans le bassin algérien, des baleines et des cachalots ont été associés à des processus de méandres ou de tourbillons (VIALE et FRONTIER, 1994) liés à l'instabilité du courant algérien (MILLOT, 1985). L'échelle de temps de ces processus est de l'ordre de l'année (MILLOT et TAUPIER-LETAGE com. pers.), alors que les résultats rapportés ici montrent des répétitions de ces taches productives sur plusieurs années ressemblant davantage à des phénomènes saisonniers (MILLOT, 1991). La campagne d'avril 94 (VIALE *et al.*, 1994) confirme les observations dans les taches trouvées en juin, début juillet, en septembre et début octobre. La production est-elle continue en ces points et liée à une incurvation du courant créée par la morphologie du talus ? En effet, celle-ci est semblable pour les deux taches extrêmes Est et Ouest ; l'action est moins claire pour la tache située au sud du Levant.

Remerciements à C. Millot et I. Taupier-Letage pour leur aide efficace, à J. Soyer et A. Guille et les membres du CIRMED-CNRS qui nous ont attribué des navires.

**Avec la collaboration technique des équipages des N/O Catherine Laurence.

RÉFÉRENCES

MILLOT C., 1985. Some features of the Algerian Current. *J. Geophys. Res.*, 90 : 7169-7176.
MILLOT C., 1991. Mesoscale and seasonal variabilities of the circulation in the western Mediterranean. *Dyn. Atmos. Oceans*, 15 : 179-214 .
VIALE, 1991. Une méthode synoptique de recherche des zones productives en mer : détection simultanée des cétacés, fronts thermiques et biomasses sous-jacentes. *Ann. Instit. Oceanogr.*, 67 (1) : 49-62
VIALE D., S. FRONTIER, J.-J. PESANDO, C. P. VIALE, P. BRACONIER, J. ROQUEFERE, N. TERRIS, 1992. Marquage réussi par balise ARGOS d'un baleinoptère en mer sans capture. *Rapp. Comm. Int. mer Médit*, 33 : 315.
VIALE and FRONTIER, 1994. Surface Megafauna related to Western Mediterranean Circulation. *Aquatic living Resources* , vol. 7, 105. 126.

THE INFLUENCE OF INTERNAL WAVES UPON THE UPPER ACTIVE LAYER STRUCTURE IN THE BLACK SEA

V. G. YAKUBENKO, I. M. OVCHINNIKOV

The Southern Branch of the Institute of Oceanology of the Russian Academy of Sciences, Gelendzhik, Russia

In the analysis hydrological and meteorological observations were used, performed by r/v "Vityaz" from February 9 till April 8, 1991 mainly in the central part of the Black sea. The calculation of heat currents through the sea surface and in the upper layer indicated that in February 1991 the conditions for thermal convection were absent both in the center of the Eastern Cyclonic Gyre (ECG) and along its periphery. This rules out the influence of horizontal advection upon the activization of convective processes. Nevertheless the hydrological analysis in the very center of ECG indicated the presence of rather important traits of convective mixing that may be connected with the existence of internal waves (IW) here.

That is why in the center of ECG at the station N 3311, made on February 18-22, 1991, special hysrophysical observations were performed with Neil-Brown probe every three hours to the depth of 150 m during 4.5 days.

The spectral analysis of the obtained data by the method of maximal entropy showed the presence of oscillations with the following periods: 4-6 days (synoptic); 33-34 hours (these oscillations appear to be an effect of the first baroclinic mode of Rossby waves or shelf waves); 16-17.3 hours (inertial waves); 11.7-12.2 hours (semi diurnal tide waves and a longitudinal single-noded seiche); 9.7 and 6 - hour oscillations (seiches peculiar to this region; BLATOV, 1984) and high-frequency oscillations with the periods of 160,20, 8.2, 5.5 min. in the upper part of the pycnocline, obtained according to the results of continuous three-hour registration of T, S and σ at the depth of 28 m. The latter had practically one-mode structure and agreed well with the spectrum GM-75. On the basis of dispersive relations (PHILLIPS, 1980) the wavelengths, local vertical scale and phase velocity were estimated for them which were changing over the range from 5 to 0.25 km, from 11 to 0.3 m and from 0.48 to 0.075 m/s respectively.

The studies of variation of IW spectral composition with depth (in the range from six-hour period to the synoptic) showed :

- in the homogeneous convective layer (HCL) the oscillations with the periods from 30 to 40 hours account for about 70% of IW total energy and the inertial and semi diurnal oscillations account for about 15%;
- in the upper part of the pycnocline (σ is from 15.1 to 15.6 kg/m^3 ; z is 25-35 m) synoptic oscillations (T is 100-150 hours) are notable. They account for 25-30% of total energy, thirty or forty-hour oscillations account for 20-25%, the inertial ones account for 10-15% and semi diurnal for 10%;
- in the rest part of the pycnocline (σ is from 15.7 to 17.6 kg/m^3 ; z is 400-200 m) the share of synoptic oscillations drops essentially (to 10%), but at the depths of 170-200 m it increases to 25-30% again; the share of energy of thirty or forty-hour oscillations increases to 25-30%, the share of energy of the inertial and semi diurnal oscillations makes up 10-15 or 5-10% respectively.

The analysis of currents in ECG demonstrated that about 90% of their variation falls on the inertial and semi diurnal oscillations, practically all the variation of currents falls on the rotating clockwise component that is the indicative of their inertial character. The estimation of spatial energetic spectral densities of current variation showed that these inertial waves were prevailing and, having the length of about 33 km, were moving to the South-East.

The obtained results indicate the important influence of IW on the formation of thermohalinic structure of the upper active layer in the Black sea. Under their influence the vertical gradients of density are considerably diminished both in HAL and in the upper part of the pycnocline that may cause the intensive mixing of waters over the pycnocline. Because of the considerable density gradients at the upper boundary of the pycnocline IW destructions are possible that results in the intensive transport of mass and properties through the upper boundary of the pycnocline.

The obtained data showed (Table) how important is to take into account the existence of IW in hydrophysical mesoscale surveys. It is quite necessary in the evaluations of thickness of HCL and the cold intermediate layer (CIL), in the studies of winter convection and other processes. The order of magnitudes of possible mistakes during measurements of hydrophysical parameters in the presence of IW for winter season in the open part of the Black Sea is given in the Table.

For the characteristic values of sigma-t σ (kg/m^3) the following symbols are used : $\Delta\sigma/\Delta z$ (kg/m^4) is a vertical gradient of density; z (m) is a mean depth; σ_z (m) is a mean-square deviation of z; $\Delta T/\Delta z$ (°C/m), $\Delta S/\Delta z$ (‰/m) - are mean for the given values of σ vertical gradients of temperature and salinity; ΔS(‰), T(°C) are deviations of salinity and temperature with the adequate σz ; R_Z, R_T, R_S (m) are maximal measured amplitudes of depth, temperature and salinity values respectively.

σ	$\Delta\sigma/\Delta z*10^{-2}$	Z	σ_Z	R_Z	$\Delta T/\Delta Z*10^{-2}$	ΔT	R_T	$\Delta S/\Delta Z*10^{-2}$	ΔS	R_S
14,95	0,56	15,3	8,55	27,8	0,3	0,25	0,28	0,05	0,004	0,26
15,00	1,40	21,9	5,53	18,8	0,3	0,165	0,32	0,5	0,0028	0,26
15,10	2,10	28,8	2,69	11,5	10,0	0,27	1,75	5,6	0,15	0,92
15,25	2,80	30,8	2,70	10,9	24,0	0,67	2,27	9,1	0,24	1,67
15,70	6,08	37,0	2,84	12,8	10,0	0,28	1,45	4,4	0,12	0,82
16,00	2,02	48,7	2,94	12,6	2,0	0,06	0,17	2,3	0,068	0,35
16,50	1,80	75,9	2,79	9,0	1,0	0,028	0,12	1,7	0,047	0,25
17,00	0,83	117,6	2,61	11,2	0,4	0,010	0,05	0,7	0,018	0,14
17,50	0,71	173,7	2,25	10,0	0,16	0,004	0,06	0,4	0,009	0,08

Table Statistical characteristics of the internal waves (IW)

REFERENCES

BLATOV A. S. *et al.*, 1984. The variation of hydrophysical fields in the Black sea. Leningrad, Gidrometeoizdat (in Russian).

PHILLIPS O. M., 1980. The dynamics of ocean upper layer.

OVCHINNIKOV I. M., M. E. VINOGRADOV, 1991. *Oceanology*, 31(6) :1081-1085.

YAKUBENKO V. G., S. E. ESAULOV, 1992. Winter condition of the Black sea ecosystem. Moscow, *Nauka*, 13-21 (in Russian). Black Sea

GENERATION OF INTENSE MESO-SCALE FLOWS OVER THE CONTINENTAL SHELF BY SHELF WAVE SCATTERING IN THE PRESENCE OF A MEAN ALONGSLOPE CURRENT

A. E. YANKOVSKY and D. C. CHAPMAN

Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA

In both the Black and Mediterranean seas, persistent narrow currents flow along the upper continental slope, roughly parallel to the local isobaths, in the direction of Kelvin wave propagation. These slope currents are accompanied by highly variable, mesoscale flow features with time scales of one to two weeks and spatial scales of O (10-100 km) which may persist in certain locations or propagate along the current, varying in both intensity and location. Particularly good examples may be found along the northwest Black sea shelf edge, where the Rim Current flows along the slope through a region of highly variable topography and coastline, and the Gulf of Lions in the northwestern Mediterranean. These mesoscale features are most often attributed to instabilities (barotropic and/or baroclinic) of the mean current as it encounters variable bottom topography or coastline. While instability processes undoubtedly play an important role in many cases, they may not be the only mechanisms which contribute to the development of these meso-scale features associated with slope currents. Sometimes meso-scale features are present along currents which appear too weak to be unstable. Furthermore, it is not always clear that the observed temporal and spatial patterns are consistent with the proposed instabilities. As an alternative mechanism, we have developed a linear, barotropic model which shows that the scattering of shelf waves in the presence of a narrow slope current may generate intense mesoscale currents in regions of strong alongshore topographic irregularities when the slope current is entirely stable. In the absence of a mean current, barotropic shelf waves may exhibit forward (long waves) or backward (short waves) energy flux propagation relative to the direction of phase propagation. The addition of the mean current enhances the shelf wave phase speeds due to the Doppler shift. This effect is small for long, low modes which travel much faster then typical mean current speeds. However, the Doppler effect is enormous for the shorter and/or higher mode waves which propagate slowly. In addition, only waves which travel faster than the maximum velocity of the mean current can exist as propagating modes. As a result, the backward propagating modes may be entirely eliminated, and the number of forward propa-gating modes can be severely limited. Figure 1 shows the effect that increasing the Rossby number has on wave frequency and the number of propagating modes. The Rossby number is defined as $\mathcal{R}o=U_{max}/fL$ where U_{max} is the maximum velocity of the mean current, f is the Coriolis parameter and L is the width of the channel. The wave frequency of the lowest three modes is not altered appreciably over this range of Rossby numbers. However, the higher modes are consecutively eliminated as $\mathcal{R}o$ increases, until only the lowest three modes can propagate when $\mathcal{R}o > 0.05$. Changes in the mean current shear also alter the shelf wave dispersion properties and structure. This effect becomes especially notable for waves whose phase speed is close to $\mathcal{R}o$. In this case, the wave structure tends to concentrate in the vicinity of the mean current and contains small-scale features near the current axis.

As the shelf wave encounters a region of varying topography/ coastline, the wave structure adjusts to satisfy the condition of no flow through the solid boundaries. This adjustment excites additional modes available at the incident wave frequency. If the mean current is absent, then a limited number of propagating modes exist at the incident wave frequency, with both forward and backward propagating waves possible. With the mean current present, only a few propagating modes may exist downstream of the scattering region, and reflection of the incident wave energy may not be possible. The regime can easily be reached in which the propagating modes which exist downstream of the scattering region are insufficient to provide the incident mode adjustment. In this case adjustment occurs through the generation of evanescent modes (e.g. NARAYANAN and WEBSTER, 1987) which do not propagate energy alongshore, but instead decay exponentially outside the scattering region, thereby introducing new spatial scales of the order of the topographic irregularities or even smaller. When the scattering is strong, the evanescent modes may be quite large, dominating the velocity field over the shelf and appearing as intense, isolated mesoscale flows. Figure 2 shows the increase in amplitude of these modes as the scattering becomes stronger. Evanescent modes can also produce a signal upstream of the scattering region, even when backward propagating modes do not exist, in agreement with the results of WILKIN and CHAPMAN (1990). In the present study the amplitudes of the evanescent modes are much larger relative to the incident and transmitted wave fields. We suspect that this mechanism may contribute to the generation of observed mesoscale flows over the shelf and slope in the presence of a mean alongslope current.

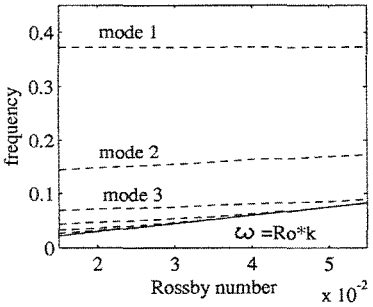


Figure 1 : Frequency ω versus the Rossby number $\mathcal{R}o$ for propagating modes at a fixed wavenumber k=1.5 (normalized by the channel width).

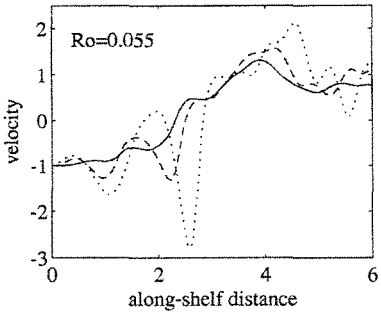


Figure 2: Along-shelf velocity component at the coast for cases of a shelf narrowing by a factor of (solid line) 1.25, (dashed line) 1.5, and (dotted line) 1.75. The velocity is normalized by the amplitude of the incident wave. The alongshelf extent of the scattering region is 1.3 to 2.5 for the two weaker scattering cases, and 1.6 to 2.8 for the strongest scattering case. Evanescent modes with wavelengths 1.3-1.5 are evident upstream and within the scattering region.

REFERENCES

NARAYANAN S. and I. WEBSTER, 1987. Coastally trapped waves in the presence of a barotropic shelf edge jet. *J. Geophys. Res.*, 92 : 9494-9502.

WILKIN J. L., and D. C. CHAPMAN, 1990. Scattering of coastal-trapped waves by irregularities in coastline and topography. *J. Phys. Oceanogr.*, 20 : 396-421.

O

INTERDISCIPLINARY STUDIES ON THE BLACK SEA WATER INFLUENCE IN THE NORTH AEGEAN SEA

G. ZODIATIS[1], S. ALEXANDRI[2], P. PAVLAKIS[2] and E. BALOPOULOS[2]
[1] Lab. Oceanography, Fishery Dpt., Nicosia, Cyprus
[2] National Centre for Marine Research, Athens, Greece

Substantial extention of our knowledge on the Black Sea Water influence in the Aegean sea has been achieved through the succesfully approach of multible objectives : a) the hydrology of the BSW origin, b) the diagnostic analysis of the frontal zones, c) the simulation of the BSW mixing processes, d) the barotropic response of the circulation and e) the reconstruction of the current vectors on the base of NOAA-AVHRR thermal data.

The *in-situ* data shows a significant seasonal fluctuation of the position of the BSW lens, northern or southern from the Limnos island. The use of diagnostic criteria such as the Kibel-Rossby number documented the existence of several types of frontal zones and intensity. Moreover, a double system frontogenesis was found to reverse seasonally (ZODIATIS, BALOPOULOS, 1993).

The circulation is prevailed by the BSW current with various scale cyclonic and anticyclonic flow regions. Numerical experiments on the circulation give evidence that a fairly strong modification of the barotropic flow response exist, due to the BSW flux through the Hellespont strait (ZODIATIS *et al.*, 1994).

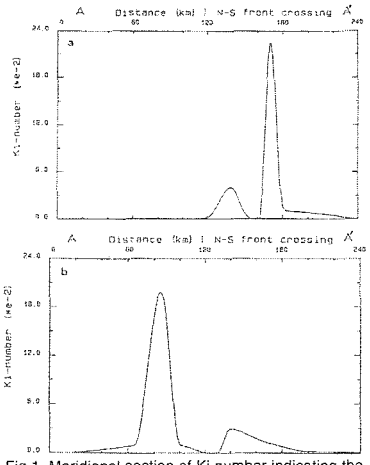


Fig.1. Meridional section of Ki number indicating the intensity of the N Aegean frontogenesis due to BSW. a) winter, b) summer seasons.

The low salinity of the BSW provides the necessary high stability buoyancy condition that restrict the homogenisation of the surface layer, despite the intense cooling and evaporation. This assumption is demonstrated through the application of 1D mixed layer model. Finally, the employment of the Maximum Cross Correlation method on satellite thermal data made possible to extract the currents in the prestrait region of Hellespont (ALEXANDRI *et al.*, 1994). These currents are comparable with the results obtained from the wind forcing flow pattern in the same period with NOAA images.

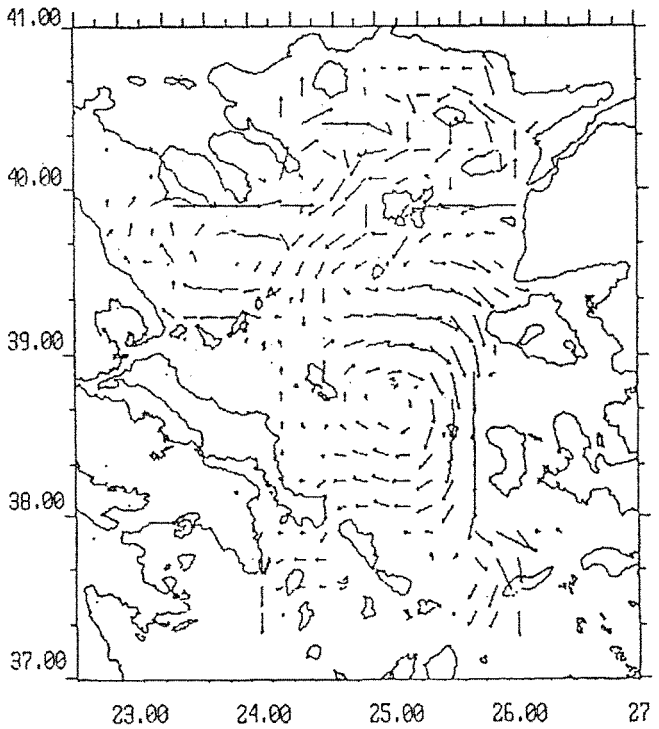


Fig.2. A case of barotropic flow response of the N Aegean with the Hellespont Strait open.

REFERENCES
ALEXANDRI S., E. BALOBOULOS, G. ZODIATIS, L. JONSSON, 1994. Currents estimation in the North Aegean sea using satellite data. *Ann Geophysicae*, Suppl. ii, 12 : 256.
ZODIATIS G., S. ALEXANDRI, E. BALOPOULOS, 1994. Modelling the Synoptic Scale Variability of the North Aegean Sea Dynamics. *Ann. Geophysicae*, Suppl. II, 12 : 247.
ZODIATIS G. and E. BALOPOULOS, 1993. Structure and Characteristics of the Fronts in the North Aegean Sea. *Boll. Oceanol. Teor. Appl.*, XI, 2.

THERMOHALINE LENS IN THE WESTERN MEDITERRANEAN SEA

G. ZODIATIS[1], G. P. GASPARINI[2], Y. Y. KLUIKOV[3], C. GALLI[2] and P. P. PROVOTOROV[3]
[1]National Centre for Marine Research, Athens, Greece & Lab. Oceanography, Fisheries Dpt., Nicosia, Cyprus
[2] CNR, Stazione Oceanographica, Pozzuolo di Lerici, Italy
[3] State Hydrometeorological Institute, St. Petersburg, Russia

Mesoscale and fine structure analysis of the water masses in the Ligurian sea revealed the presence of a cool less saline thermohaline lens. This lens with temperature .8 and salinity .4 differences, from the surrounding waters, extended vertically at about 100 m between 300 - 400 m depth and horizontally about 20 km. Similar cool less saline lenses were found at the sub-polar front in the North Atlantic (KARLIN *et al.*, 1988) and in the SE Ionian sea (ZODIATIS, 1992), in contrast to the salt Meddies and Reddies (ARMI & ZENK, 1984; FEDOROV & MESCHANOV, 1988).

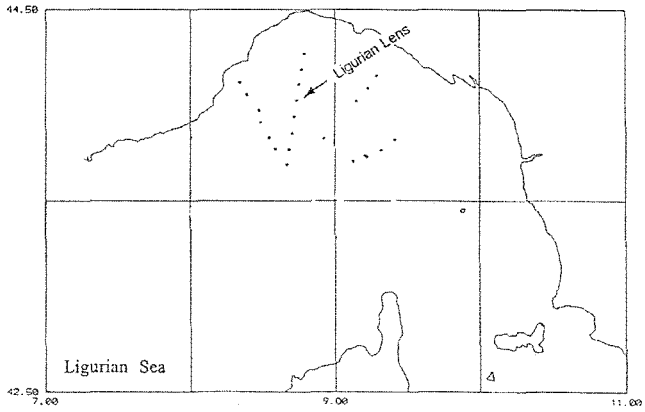


Figure 1. LIGUR 1991 (April)

Two possible mechanisms of such lens formation are proposed: a) frontal intrusive, due to isopycnic flow of denser surface water over a thermohaline frontal slope and b) convective one, due to the advection of residual winter intermediate layer. Various diagnostic fine structure and frontogenesis parameters, the density ratio, slope angles of T, S, density, isopycnic gradients were employed on the T(z), S(z).

The data processing indicates that the salt finger instabilities were favourable to be developed in the upper lens boundary, while diffusive convection instabilities were likely to appear in the lower lens interface. The contribution of the temper ature on the density gradient found to be greater than of the salinity, as the density ratio does not exceed the Rp = <.5 value. In addition, at the lens boundaries the like frontal interface is distinguished by the increase of the thermocline. The latter indirectly give evidence on the intrusive origin of the lens. Such intrusion may contribute to a substantial heat-salt fluxes, vertical mixing through the pycnocline.

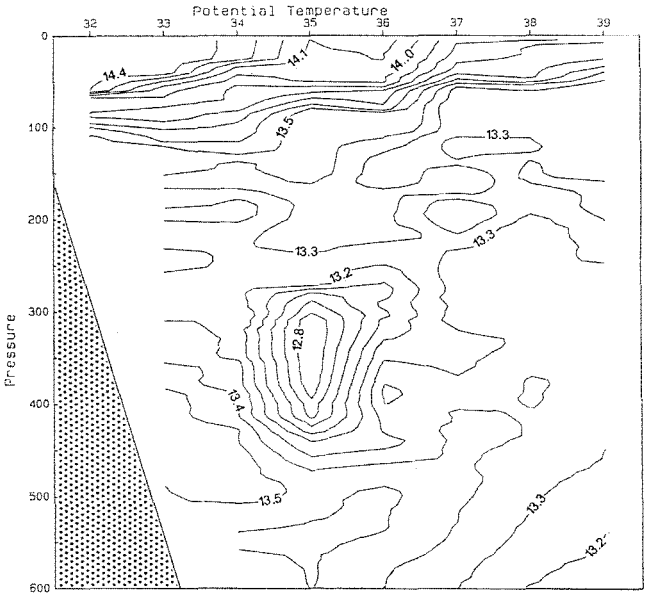


Figure 2. Ligurian lens - revealed by vertical temperature distribution

REFERENCES
ARMI L., W. ZENK, 1984. Large lenses of highly saline Mediterranean water. *J. Phys. Oceanogr.*, 14 : 1560-1576.
FEDOROV K., S.L. MESCHANOV, 1988. Structure and propagation of Red sea waters in the Gulf of Aden. *Oceanology*, 28 : 279-284.
KARLIN L., Y.Y. KLUIKOV, B.P. KUTKO, 1988. The Microscale structure of the hydrophysical fields at the upper layer of Ocean. Gidrometeoizdat. 162 p., Moscow.
ZODIATIS G., 1992. Lens formation in the SE Ionian Sea and Double Diffusion. *Ann. Geophysicae*, 10 : 935-942.

P

COMITÉ PLANCTON

Président : Jean GODEAUX
Vice-Présidents : Adriana IANORA, Sami LAKKIS

CONTRIBUTION À L'ÉTUDE DE LA BIOMASSE ZOOPLANCTONIQUE DANS LES EAUX CÔTIÈRES DE LATTAQUIE (SYRIE)

Mohamed BAKER

Marine Research Institute, P.O.Box 2242,Tishreen University, Lattakia, Syria

L'étude de la biomasse est nécessaire pour évaluer le stockage en matière vivante du milieu étudié. Les travaux relatifs à l'étude du zooplancton dans les eaux syriennes n'ont commencé qu'au début des années quatre-vingt-dix (BAKER *et al.*, 1992). Notre étude est basée sur 36 échantillons, prélevés lors de 12 sorties en mer. Elle a été réalisée en deux ans, entre mars et octobre 1991 et entre avril et octobre 1992, avec une sortie par mois en moyenne. Les prélèvements zooplanctoniques ont été effectués en surface (- 0.5 m.) à l'aide d'un filet de type WP2 (200 um de vide de maille, 176 cm. de diamètre et 56 cm. de diamètre d'ouverture) et avec une durée de pêche de 5 minutes et une capacité de filtration égale à 100% .

Trois stations à caractéristiques écologiques différentes ont été retenues : St 1, considérée exempte de toute pollution à l'inverse des deux autres stations, St. 2, située à l'entrée du port de Lattaquié et St 3, en face d'un estuaire. Des mesures hydrologiques et chimiques, réalisées en même temps, ont montré que les trois stations diffèrent essentiellement par le degré de pollution mais aussi par la salinité, surtout la station 3 d'une part et les stations 1 et 2 d'autre part.

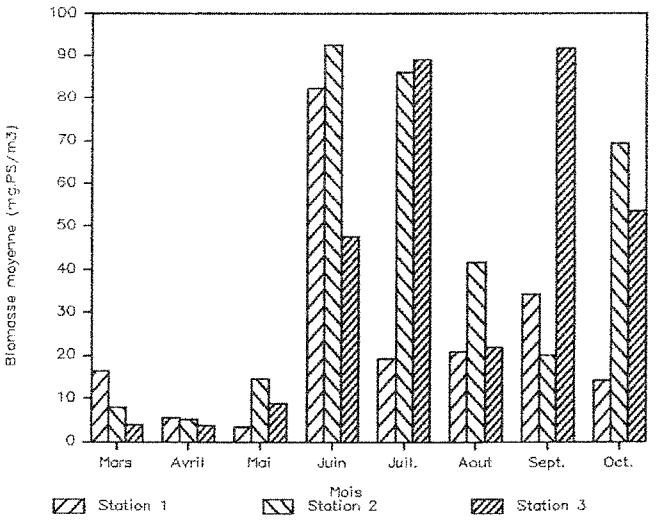
La détermination du zooplancton est faite jusqu'à l'espèce; le comptage des individus de chaque espèce est réalisé dans des sous-échantillons. La biomasse (mg poids sec/m^3) des différentes espèces a été calculée en multipliant l'abondance/m^3 (calculée, à son tour, à partir de la longueur du trajet parcouru par le bateau et l'ouverture du filet) par le poids sec moyen d'un individu pour chaque espèce.

Plus de 112 espèces, dont 54 de copépodes, ont été identifiées; en outre, 14 autres groupes étaient représentés dans nos échantillons. La biomasse zooplanctonique montre des variations spatiales et temporelles très importantes (figure 1); la période printanière se caractérise par une faible biomasse (max: 16 mgPS/m^3). Deux poussées remarquables sont enregistrées : une estivale (juin-juillet), l'autre automnale (septembre-octobre). En général, les stations soumises aux sources de pollution (2 et 3) ont été plus riches en biomasse (42,1 mgPS/m^3, moyenne mensuelle sur 8 mois) que la station 1 (24,5 mgPS /m^3).

Les copépodes représentent le groupe le plus important au sein de la communauté zooplanctonique dans les eaux étudiées. Ils constituent entre 13,1 et 99,6% de la biomasse totale obtenue. Les espèce dominantes dans ce groupe, en nombre et en biomasse, sont souvent: *Clausocalanus furcatus, C. furcatus, Paracalanus parvu, Oithona plumifera.* Outre les copépodes, la contribution des ptéropodes était parfois très remarquable, pouvant atteindre 85% (en automne : St 3) de la biomasse totale; *Limacina inflata* était l'espèce dominante dans la majorité des échantillons. La contribution des hydroméduses et siphonophores varie respectivement entre 0 (printemps) et 48% (été, automne) et entre 0 et 36% (été) avec la dominance de *Obelia* sp. *Chelophyes appendiculata.* Malgré leur présence quasi-permanente, les biomasses des larves de crustacés, des chaetognathes et des appendiculaires ne constituent que 18, 16 et 13%, respectivement de la biomasse zooplanctonique totale. Les salpes ont été le principal concurrent des copépodes en mars 1991 avec la dominance de *Thalia democratica.*

La majorité des valeurs que nous avons obtenues pour la biomasse totale est comparable à celles de PASTEUR *et al.* (1976) pour le bassin levantin, YANNOPOULOS & YANNOPOULOS (1976) pour la baie d'Elfsis et de BOISSON *et al.* (1985) pour la baie de Monaco.

Fig.1: Evolution spatio-temporelle de la biomasse zooplanctonique dans les eaux étudiées.



RÉFÉRENCES:

BAKER M., NOUREDDIN S. & YOUSSEF A.K., 1992.- XXXIInd Science Week. Damascus, Syria. 2(2): 299-326.

BOISSON M., CORLETTI Y & VAISSIERE R., 1985.- *Rapp. Comm. int. Mer Médit.*, 29 (9): 311-317.

PASTEUR R., BERDUGO V. & KIMOR B., 1976- *Acta Adriatica*, 53: 357-408.

YANNOPOULOS C. and YANNOPOULOS A., 1976.- *Thalassia Jugoslavica.* 7 (1): 329-337.

APPEARANCE OF HYDROMEDUSAE IN THE NORTHERN ADRIATIC SEA IN 1992 AND 1993

A. BENOVIC and D. LUCIC

Biological Institute, P.O.Box 39, 50000 Dubrovnik, Croatia

Hydromedusae are among best studied plankton groups in the Northern Adriatic Sea (NEPPI & STIASNY, 1913, BENOVIC, 1973). Northern Adriatic fauna, including hydromedusae, is subjected to strong ecological stress due to hypoxic and anoxic events during summer months (OREL *et al.*, 1993), and many species have disappeared from the area (BENOVIC *et al.*, 1987). To check hydromedusan fauna after these ecological stresses, the present work reports the incidence of hydromedusae collected during the Alpe-Adria Cooperative Research Program (Italy, Austria, Slovenia and Croatia) cruises of 1992 and 1993. Hydromedusae were sampled monthly at stations indicated in Figure 1. Bottom-to-surface vertical tows with 0.20 mm WP2 (stations A, A3, F1) and 0.25 mm NANSEN (other stations) mesh plankton nets were used to measure abundance. Total numbers of hydromedusae were determined from entire catch and are expressed on a per-square-meter basis. Fourteen species were identified (Table 1): 6 Anthomedusae, 6 Leptomedusae, 1 Trachymedusa and 2 Narcomedusae (because of inadequate preservation, Narcomedusae were not separable between *Solmaris leucostyla* and *S. vanhoeffeni*). Seven species (a, d, g, h, k, m, n) were found in both warmer and colder months, but highest abundance was restricted to warmer months. Other seven species were rarely encountered and 3 (e, j, l) were noted but once (Table 1). Number of individuals shows domination of only 3 Anthomedusae (a, c, d) and 2 Leptomedusae (g, h). Leptomedusae i and k, Trachymedusa m and Narcomedusa n have shown notable presence, while we can indicate as very rare other species of Anthomedusae (b, e, f) and Leptomedusae (j, l). With the exception of stations SJ-007 and ZI-012, spatial distribution of hydromedusae was higher along the eastern portion of the study area (Fig.1). The lowest number of species was observed in front of the Pô River (Station SJ-101). These data support earlier observations on the decrease in the number of hydromedusae species in the Northern Adriatic (BENOVIC *et al.*,1987). The few rare species reported in 1965 (BENOVIC, 1973) were noted again; their appearance, mainly in the eastern part of the area, could be related to the stronger currents from the south observed in 1991-1993 (M. CELIO, pers.comm.).

	Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Fig. code	SPECIES												
a	Sarsia gemnifera	1	1	31	7	514	1093	1	42	9			
b	Corymorpha nutans			1			3						
c	Podocoryne minima			1		14	61	7	294		2	12	
d	Podocoryne mmuta			12	8	29	259	53	257	258	19	118	9
e	Bougainvillia ramosa					1							
f	Thamnostoma dibalia						5				2	2	
g	Obelia sp.	1	1	41	30	19	2	4	2	1	27	29	28
h	Clytia hemisphaerica			1	1	10	2	1	905	1549	1	16	9
i	Eirene viridula			11		1	1	7		1			
j	Aequorea aequorea					1							
k	Eutima gracilis				1	10	10	6	5	2	1	1	
l	Helgicirrha schulzei								13				
m	Liriope tetraphylla				1		85		7		1	14	
n	Solmaris spp.	1			1	2		1	2		3	1	

Tab. 1. Annual appearance of hydromedusae in the Northern Adriatic Sea. Numbers represent total monthly appearance of species for 1992 and 1993 in entire area of investigation in water column of the surface area of 1m^2.

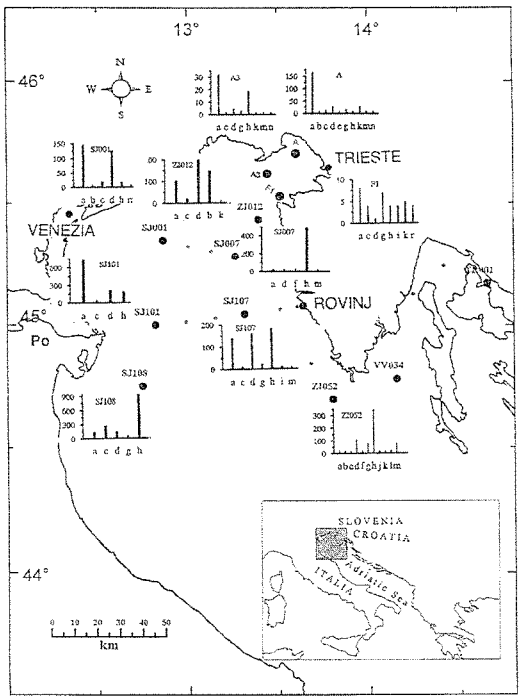


Fig. 1. Spatial appearance of hydromedusae in the Northern Adriatic Sea. Ordinate numbers represent total appearance of individuals for 1992 and 1993 in water column of the surface area of 1m^2.

REFERENCES

BENOVIC A. 1973. Idromeduse dell'Adriatico Settentrionale nell'anno 1965. *Boll.Pesca Piscic.Idrobiol.* 28, 1 : 59-70.

BENOVIC A., D. JUSTIC and A. BENDER. 1987. Enigmatic changes in the hydromedusan fauna of the Northern Adriatic Sea. *Nature*, 6113 : 597-600.

NEPPIV. and STIASNY G. 1913. Die Hydromedusen des Golfes von Triest. *Arb. Zool. Inst. Wien-Triest*, 20 : 23-92.

OREL,G., S.FONDA-UMANI et ALEFFI, F. 1993. Ipossie e anossie di fondali marini L'Alto Adriatico e di Golfo di Trieste. Ed. Regione Autonomia Friuli-Venezia Giulia, Trieste, pp. 104.

P

DISTRIBUTION DES TUNICIERS PÉLAGIQUES DOLIOLIDES À VILLEFRANCHE: 10 ANNÉES D'OBSERVATIONS

J. C. BRACONNOT et S. DALLOT

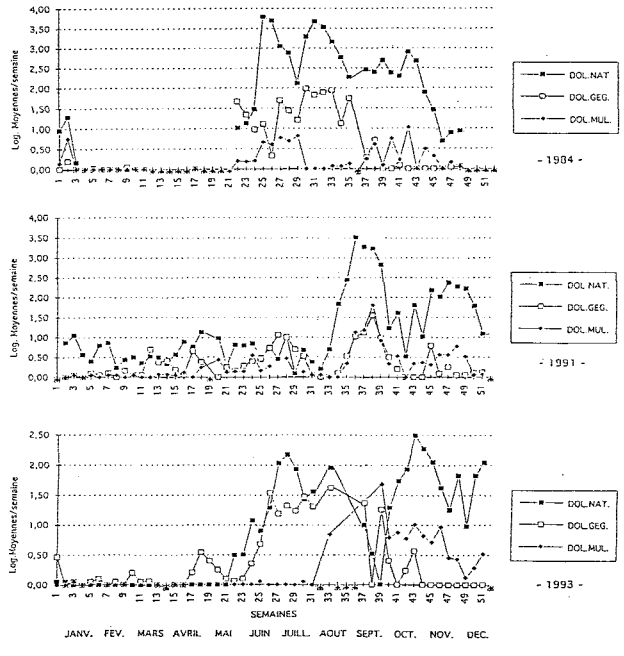
CNRS, UA 716, Station Zoologique, Observatoire océanologique, 06230 Villefranche-sur-mer, France

Chez les Thaliacés, on ne considère généralement que les Salpides comme ayant un réel impact écologique. Il est certain que les pullulations observées à certaines périodes de l'année se remarquent facilement du fait de la taille relativement importante des individus qui, en filtrant le milieu, épuisent le phytoplancton et le maintiennent dans un état de renouvellement intense. Parmi les Doliolides, une espèce au moins, *Doliolum nationalis* Borgert 1894, peut prétendre au même résultat car elle atteint des densités énormes grâce au cycle simplifié dû au bourgeonnement des individus par eux-mêmes (cycle court, BRACONNOT 1967). Les populations de Doliolides ont été dénombrées pendant une dizaine d'années (*) en un point situé à la sortie de la rade de Villefranche dans des pêches verticales 75-0 m avec un filet de 1 m de diamètre et de 700 µm de vide de maille (pour éviter une trop grande quantité de petits copépodes qui gêneraient le tri) une fois par jour ouvrable. A titre d'exemple, les distributions de 3 années sont montrées ici avec des moyennes hebdomadaires des 3 espèces principales, exprimées en logarithme décimal du nombre d'individus dans 100 m^3: le phorozoïde de *Doliolum nationalis* Borgert 1893, tous stades confondus de *Dolioletta gegenbauri* Uljanin 1884 dont les effectifs approchent, certaines années, le seuil permettant un rôle écologique possible et de *Doliolina mülleri* Krohn 1852 qui ont un rôle écologique très douteux. Aucune de ces deux espèces n'atteint jamais les grands effectifs de la première, la dernière, plus petite, est probablement un peu sous-échantillonnée par notre filet à grande maille. *Doliolum denticulatum* Q & G 1834 qui a été citée comme la plus abondante à Villefranche dans des publications anciennes, est totalement absente de nos récoltes.

Doliolum nationalis est présente en faible quantité presque toute l'année; elle est très abondante pendant quelques mois généralement dans le deuxième semestre (été et automne comme en 1991 par exemple); cette distribution n'est pas exactement la même selon les années. Au printemps, généralement, la présence des populations de Salpides est en concurrence directe avec les Doliolides qui sont absentes ou quelquefois en faible quantité non mesurable dans la masse des Salpes (cas de 1984). Pendant la longue période d'abondance, contrairement aux Salpides, plusieurs grands maximums s'observent, séparés par des quasi-disparitions de une ou deux semaines. On peut se demander si cela n'est pas dû au choix de notre station de prélèvement : point assez côtier pour garantir la possibilité d'une grande fréquence de pêches (quotidiennes) mais en même temps représentatif des populations de la mer Ligure, populations du large qui sont celles qui alimentent notre point de prélèvement. Les perturbations locales de courte durée influent en effet sur les résultats instantanés mais ne sont plus sensibles sur l'ensemble des moyennes. La position des maximums est assez variable, le plus souvent en fin d'été ou en automne. Le problème de la reconquête du milieu après une longue période d'absence ne se pose pas dans les mêmes termes que chez les Salpides car il n'y a pas vraiment de disparition de l'espèce en surface pendant plusieurs mois. Des individus isolés sont récoltés, ils témoignent d'une présence permanente peu décelable avec nos moyens, pêches qui ne filtrent chaque jour que 60 m^3.

L'intérêt des descriptions des populations de toutes ces années réside dans leur utilisation soit dans des études de biodiversité, successions d'espèces, place dans la niche écologique, soit lors d'études de l'influence de variables environnementales sur les composants du réseau alimentaire pélagique (MÉNARD *et al.* 1994), ou tout simplement dans des programmes d'océanographie côtière comme on en voit se développer en ce moment (Programme PNOC en France).

(*) années 1963 à 1967, 1984 et 1990 à 1993. Tous les graphiques figurent sur une "affiche scientifique" présentée conjointement à la présente note.



RÉFÉRENCES:

BRACONNOT J.C., 1967. Sur la possibilité d'un cycle court de développement chez le Tunicier pélagique *Doliolum nationalis* Borgert. C. *R. Acad. Sci. Paris*, 264 : 1434.

MÉNARD F., DALLOT S., THOMAS G., BRACONNOT J.C., 1994. Temporal fluctuations of two Mediterranean salp populations from 1967 to 1990. Analysis of the influence of environmental variables using a Markov chain model. *Mar. Ecol. Progr. Ser.* 104 : 139-152.

ANNUAL CYCLE OF *DINOPHYSIS* SPP. IN THE GULF OF TRIESTE

Marina CABRINI and Paola DEL NEGRO

Laboratory of Marine Biology, Trieste, Italy

Since 1930 (SCHILLER, 1933-37) toxic species belonging to the *Dinophysis* genus occured in Adriatic Sea but only from 1989 these dinoflagellates have been correlated to cases of DSP (Diarrhetic Shellfish Poisoning) along the coasts of Emilia Romagna (BONI *et al.*, 1992). Because of the presence of DSP toxins in mussels, molluscs harvesting and marketing were prohibited every summer since 1989 with negative economic effects. *Mytilus galloprovincialis* farms represent one of the major industries in the Gulf of Trieste employing 200 people and producing 9000 t. yr-1. As 200 *Dinophysis*/liter are sufficient to render mussels toxic (ALVITO *et al.*, 1990), a toxic phytoplankton monitoring programme in mussel farms seawater became necessary.

From September 1990 until September 1991, a monitoring programme to identify *Dinophysis* spp. was carried out in a mussel farm located 200 m offshore in the Gulf of Trieste. Water samples were collected at 0.5 m, 2 m, 5 m, 10 m and at the bottom (13 m). *Dinophysis* species were identified and counted according to UTERMÖHL (1958) method after sedimentation of 100 ml of a preserved sample (CABRINI and DEL NEGRO, 1992).

Dinophysis is never observed as the dominant dinoflagellate in the Gulf of Trieste; in fact, the higher density corresponds to 870 cells/liter (Fig.1). A significant presence was found in September and October 1990; subsequently, sporadic occurences were detected until May 1991 when *Dinophysis* spp. were again present. *D.* cf. *acuminata*, *D. caudata*, *D. fortii*, *D. rotundata*, *D. sacculus* and *D. tripos* were identified along the water column and among these species *D. fortii* and *D.* cf. *acuminata* were the most abundant ones.

The vertical distribution underlines the presence of *Dinophysis* along the water column. At surface *Dinophysis* spp. were detected from September to October 1990 and reached maximum value (190 cells/l) with *D. caudata*. The year after *D.* cf. *acuminata* was the most abundant species reaching 180 cells/l in May. At 2 m, the 1990 temporal trend is similar to surface distribution: the highest value is recorded in October with 610 cells/l of *D. fortii*. This species reached significant concentrations also at 5 m in 1990 with density higher in September than in October and it was present in 1991 too. At 10 m *Dinophysis*, particularly *D. fortii* and *D. caudata*, was observed in autumn 1990. An unusual presence of *D. rotundata* was recorded in the next January. Few cells, particularly *D. fortii*, occured then in May and September. At the bottom, density as well as specific diversity were always lower than at the other depths.

According to previous papers (CABRINI *et al.*, 1987/88; DEL NEGRO *et al.*, 1992), a seasonality of *Dinophysis* presence is evident at all the considered depths. A different seasonal pattern in specie-specific composition is shown: *D. fortii* and *D. caudata* are dominant in autumn while *D.* cf. *acuminata* reaches maximum values in early spring. Quantitatively *Dinophysis* prefers the middle depths rather than surface.

From these observations it results that *D. caudata* decreases from 190 to 30 cells/liter in surface, while *D. fortii* increases from 20 to 610 cells/liter at 2 m depth in only seven days. For this reason the monitoring programme on *Dinophysis* must be intensified at the points of view frequency and depth number in order to control this toxic species in the whole water column.

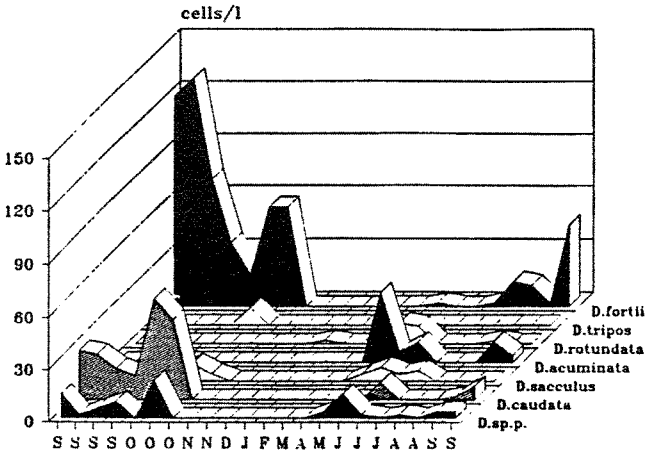


Fig. 1 - Distribution of *Dinophysis* (cells/l represents mean value for the water column).

REFERENCES

ALVITO P., SOUSA I., FRANCA S., SAMPAYO M. A. DE M. 1990.- Toxic Marine Phytoplankton. E. Granlj, B. Sundstrom, L. Edler, D.M. Anderson (Eds.). Elsevier : 443-448.

BONI L., MANCINI L., MILANDRI A., POLETTI R., POMPEI M., Viviani R. 1992.- *Sci. Total Environ.*, Suppl. 1992 : 419-426.

CABRINI M. & DEL NEGRO P. 1993.- *Biologia Marina*, suppl. Notiziario S.I.B.M., 1 : 251-254.

CABRINI M., MILANI L., HONSELL G., FONDA UMANI S. 1987-1988 - *Nova Thalassia*, 9 : 11-52.

DEL NEGRO P., CABRINI M. and TULLI F. 1993.- Production, Environment and Quality. Bordeaux Aquaculture '92. G. Barnabè and P. Kestemont (Eds.). European Aquaculture Society. Special Publication N. 18 : 555-562.

SCHILLER J. 1933-37.- Leipzig, Akad. Verlag., vol. 10 (3), Teil 1, 1-617 (1931-33): Teil 2, 1-590 (1935-37).

UTERMOHL H. 1958.- *Mitt. int. Ver. Theor. angew. Limnol.*, 9 : 1-38.

NUTRIENT AND CHLOROPHYLL *A* DISTRIBUTION IN RELATION TO WATER COLUMN STRUCTURE IN THE MALI STON BAY (SOUTHERN ADRIATIC)

Marina CARIC and Nenad JASPRICA

Biological Institute, HR-50001 Dubrovnik, Croatia

Sampling was performed once a month at Usko station (12 m max. depth) in the Bay of Mali Ston from February 88 to February 89. The Bay of Mali Ston is an unpolluted area favouring oyster and mussel farming. This area is influenced by the fresh water income from the Neretva river at the outher part and submarine springs in the inner part. Parameters were determined by standard oceanographic methods (STRICKLAND and PARSONS, 1972).

The aim of this work has been to describe the distribution of nutrients and chlorophyll *a*, as well as their respective correlation to hydrodynamic characteristics of the water column. According to these hydrodynamic characteristics of the water column recorded throughout the year, two different periods were observed to exist : mixing (October-April) and stratification (May-September). During the stratification period, water column was divided into three layers: above, at and below pycnocline depth. The data on ranges, means and standard deviations of parameters investigated for annual, mixing and stratification periods are presented in Table 1. During the stratification period, all the parameters, except ammonia and reactive silicate, had the lowest range, mean and standard deviation. As regards the parameters above, at and below pycnocline, maximum values, excepting ammonia, were found above pycnocline depth. Significant difference between the layers was found only in nitrate and reactive phosphorus (Table 2).

Table 1. Range, mean, standard deviation (SD) of nutrients and chlorophyll *a* in annual, mixing and stratification periods.

	Annual (n=83)			Mixing (n=49)			Stratification (n=34)		
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
c (NO_3)	0.96	1.54	0.01-9.73	1.28	1.90	0.06-9.73	0.53	0.65	0.00-2.52
c (NO_2)	0.14	0.22	0.01-1.11	0.21	0.27	0.01-1.11	0.04	0.03	0.01-0.13
c (NH_4)	0.72	0.84	0.01-3.98	0.62	0.60	0.05-2.20	0.86	0.89	0.01-3.98
c (TIN)	1.82	1.82	0.14-10.70	2.10	2.12	0.17-10.70	1.43	1.24	0.14-5.02
c (PO_4)	0.09	0.06	0.01-0.33	0.09	0.06	0.01-0.33	0.08	0.05	0.03-0.29
c (SiO_4)	2.92	1.77	0.21-7.15	3.16	1.70	0.21-6.18	2.59	1.85	0.37-7.15
φ O_2/O_2'	1.09	0.10	0.86-1.32	1.03	0.08	0.86-1.32	1.18	0.05	1.06-1.29
Chl *a*	1.44	1.54	0.21-6.73	1.94	1.84	0.25-6.73	0.77	0.37	0.21-1.58

c- μmol dm-3, chl a - μg dm-3

Table 2. The means of nutrients and chlorophyll *a* in pycnocline layers.

Layers	NO_3	NO_2	NH_4	TIN	PO_4	SiO_4	O_2/O_2'	Chl *a*
Above	1.10^{a*}	0.05	0.78	1.94	$0.11^{a,a*}$	3.46	1.20	0.86
At	0.39^{b*}	0.03	0.71	1.13	$0.05^{b,b*}$	2.22	1.19	0.73
Below	0.20^{b*}	0.04	0.94	1.19	0.08^{c}	2.34	1.16	0.73

*The means in the same column followed by different superscript are significantly different P<0.05, with * P<0.01 (ANOVA, SNK-multiple range test).*

A simple correlation coefficient, both negative and positive, was found among chlorophyll *a* and nutrients (Table 3). The correlation was not established to exist on an annual basis, except for nitrite. Chlorophyll *a* was significantly correlated to ammonia, total inorganic nitrogen (P<0.001), nitrite, reactive silicate (P<0.01) and reactive phosphorus (P<0.05) during the stratification period. During the mixing period, chlorophyll *a* significantly correlated only with reactive silicate (P<0.001). During the stratification period (at different levels), chlorophyll *a* significantly depended upon reactive silicate, ammonia and total inorganic nitrogen above pycnocline depth, with nitrite, ammonia, total inorganic nitrogen and reactive phosphorus (P<0.01) below pycnocline depth (Table 4). At pycnocline depth, the depedence was not established.

An intensive development of phytoplankton preceding the stratification period caused a decrease in concentration of most nutrients. An increase in reactive silicate concentration was caused by a haline stratification, namely, a fresh water influx, while high ammonia concentration recorded throughout the water column and especially below the pycnocline is indicative of a high heterotrophic activity. Most significant correlations between chlorophyll *a* and nutrients were found during the stratification period, especially below pycnocline depth.

Table 3. Simple correlation coefficients between chlorophyll *a* and nutrients for annual data (A),mixing (M) and stratification (S) periods.

		NO_3	NO_2	NH_4	TIN	PO_4	SiO_4
	A	0.033	0.299*	0.066	0.172	0.207	-0.182
Chl *a*	M	-0.215	0.175	0.179	-0.030	0.195	-0.522***
	S	0.229	0.537**	0.631***	0.583***	0.401*	0.539**

** P<0.05, ** P<0.01, *** P<0.001.*

Table 4. Simple correlation coefficients between chlorophyll *a* and nutrients in three layers during stratification period.

		NO_3	NO_2	NH_4	TIN	PO_4	SiO_4
	Above	0.442	0.486	0.612*	0.642*	0.377	0.666***
Chl *a*	At	-0.308	0.058	0.552	0.404	-0.107	0.152
	Below	0.078	0.599**	0.684**	0.677**	0.607**	0.190

** P<0.05, ** P<0.01, *** P<0.001.*

REFERENCE

STRICKLAND J. D. H. and PARSONS T. R., 1972. A practical handbook of seawater analysis. *Bull. Fish. Res. Bd. Can.*, 167 : 310 p.

DIEL MESOZOOPLANKTON ACTIVITY IN AN OLIGOTROPHIC STATION OF NW MEDITERRANEAN: POSSIBLE IMPLICATIONS ON THE MICROBIAL LOOP

U. CHRISTAKI[1], R. GAUDY[1], P. KERAMBRUN[2], E. CHRISTOU[3]

[1] Station marine d'Endoume, Rue de la Batterie des Lions, 13007 Marseille, France.
[2] Centre d' Océanologie de Marseille, Campus de Luminy, 13288 Marseille, France.
[3] National Centre for Marine Research. Ag. Kosmas Hellinikon, 16004 Athens, Greece.

The diel migration of zooplankton is an extensively studied phenomenon. Other zooplankton activities such as ingestion of food (DAGG & GRILL, 1980) and the activity of digestive enzymes (BOUCHER & SAMAIN, 1974) may also show a diel variation. In this study (1) the coupling between the diel variations of nutrition and migration of the zooplankton (2) the possible effect of the zooplankton migration on planktonic microorganisms (pico and nanoplankton i.e., bacteria and nanoflagellates) were examined. For this purpose a diel cycle of sampling was undertaken on a fixed oceanic station (43° 02 N, 05° 12 E, 1000 m depth) in June 1993.

The biological parameters measured included chlorophyll *a*, concentration of bacteria, phototrophic and heterotrophic nanoflagellates, ciliates and mesozooplankton. Water samples were collected at three hour intervals over a 24 h period from 5 and 40 m depths. Mesozooplankton samples were collected by vertical hauls (50-0 m, WP2 net). Triplicate zooplankton samples (mainly copepods, 81%) were incubated during 24 h, in filtered seawater (0.2 μm). Dissolved oxygen (polarographic electrode) and ammonia (colorimetric method) were measured at the end of the experiment and the atomic ratio O:N (oxygen consumption through respiration, relative to nitrogen excretion) was calculated (OMORI & IKEDA, 1984). The gut fluorescence (from acetone extracts of zooplankton), digestive enzymes, amylase (STREET & CLOSE, 1956) and trypsin (ERLANGER *et al.*, 1961) were measured from subsamples of zooplankton stored in liquid nitrogen within a week of sampling. Bacterial production was measured by the [^{3}H]thymidine method. Copepods numerically dominated (71%) the zooplankton population. Four copepod genera -*Clausocalanus* spp., *Paracalanus* spp., *Oithona* spp. and *Centropages* sp. prevailed in the copepod community. Appendicularians (12%) and Cladocerans (13%) were also recorded. The abundance of zooplankton was higher in the surface layer (50-0 m) during the night hours than during the day (min. 454 ind.m^{-3} at 15h00, max 1490 ind.m^{-3} at 24h00, (Fig. 1). The effect of zooplankton migration on chlorohyll concentration and on organims that could potentially be used as prey (e.g. nanoflagellates) was not clear. In fact no significant differences (Mann-Whitney test) were found between day and night samples. Microscopic examination showed that, organisms less than 7 μm prevailed in the nanoflagellate population; moreover chlorophyll size fractionation revealed that about 70% of phytoplankton was < 10 μm. These observations could suggest that copepods preferred to graze upon bigger organisms (large flagellates, phytoplankton and ciliates). Significant differences in bacterial numbers were found between night and day samples (Mann-Whitney test t=2, p= 0.005). Bacteria can adapt quickly to nutritional resources (bottom-up control), especially in oligotrophic conditions (PEDUZZI & HERNDL, 1992). The increase of bacteria production in evening hours (Fig. 2) suggests a response to extracellular releases by the phytoplankton during daylight hours (FUHRMAN *et al.*, 1985). The second increase observed in the early morning is possibly related with the intensified zooplankton activity (excretion, sloppy feeding) during the night (HERNDL & MALACIC, 1987). The O:N ratio is used as a clue to the type of substrate (carbohydrates vs proteins) being oxidized through respiration (GAUDY & BOUCHER 1983). The atomic ratio O:N calculated for zooplankton suggests by its low value (9.4), the ingestion of a food containing a high proportion of nitrogen i.e., microzooplankton or detritus, possibly harbouring attached bacteria and their protozoan predators (OMORI & IKEDA, 1984). According to LANDRY (1981), copepods can switch from herbivory to carnivory depending upon the availability and concentration of plant or animal prey. During the diel cycle analyzed here, the heterotrophic biomass (bacteria + heterotrophic flagellate + ciliates + mesozooplankton) dominated the autotrophic biomass, the ratio of chlorophyll biomass/heterotrophic biomass being 0.33. This situation is not uncommon in oligotrophic waters (FUHRMAN *et al.*, 1989). The night increase of zooplankton biomass (max. at 24 in surface water) was correlated to an increase of the specific activity of digestive enzymes (amylase and trypsin, max. at 3 h, Fig. 3), these observations suggest a coupling between migration and feeding of zooplankton (BOUCHER & SAMAIN 1974). When one specific species of the zooplankton population was considered (*Centropages typicus*) the nutritional activity (max. at 24 h, Fig. 4) corresponded to a parallel increase of the utilisation of autotrophic material (max. at 24 h, Fig. 4) as have already showed (DAGG & GRILL, 1980) for this species.

The results of this study, must be considered as a preliminary approach to the study of complex interactions between planktonic organisms which may vary between seasons. Nevertheless, they illustrate the interest to consider simultaneously the distribution and physiology of planktonic organisms in order to study their possible interactions.

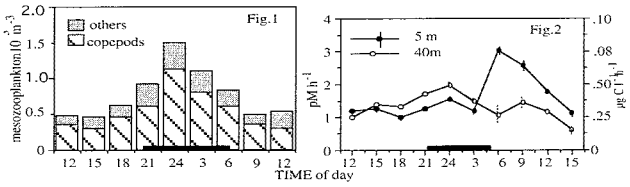


Figure 1. Diel cycle of the abundance of mesozooplankton.Heavy lines on x-axis indicates hours of darkness.Figure 2. Diel evolution of [methyl3H]-thymidine (Tdr) incorporation rates. The right-hand scale indicates the bacterial production (μg C l-1 h-1).

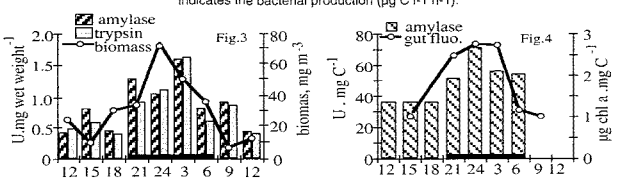


Figure 3.Diel variation of specific activity of digestive enzymes (units mg wet weight^{-1}) and of the zooplankton biomass(wet weight m^{-3}). Figure 4. Diel evolution of amylase activity (units mg C-1) and gut fluorescence (μg chl a mg C-1) for the copepod *Centropages typicus*.

This study was supported by: CEC B/MAST/913008. PNOC (Programme National d'Océanographie Côtière. JGOFS France) and PLATON (Collaboration Franco-Hellénique 92802).

P

ANNUAL CYCLE OF CLADOCERANS IN THE SARONIKOS GULF (HELLAS)

E. D. CHRISTOU, I. SIOKOU-FRANGOU, E. PAPATHANASSIOU

National Centre for Marine Research, Agios Kosmas, Hellinikon,16604 Athens, Greece

Marine cladocerans, occurring predominantly in coastal waters, may significantly contribute to zooplankton especially from early spring to late autumn. Forty-three samples were collected by oblique hauls at 7 and 15 days intervals from a coastal station (about 12 m depth) in the Eastern Saronikos Gulf (Aegean Sea, Eastern Mediterranean) during the period January through December 1989. A 200 µm net (WP2) equipped with a Hydrobios flowmeter was used. Two major peaks of total zooplankton abundance (> 5000 ind. m^{-3}) were recorded (Fig. 1); the first was due to the copepod maximum (4623 ind. m^{-3}) in late April whereas the second was due to the cladoceran maximum (5170 ind. m^{-3}) in late June. The cladoceran population, formed by six species (KIORTSIS & MORAITOU-APOSTOLOPOULOU, 1975), clearly predominated the zooplankton community during summer and early autumn. *Penilia avirostris*, attaining very high numbers from June to August (max 3130 ind. m^{-3}), was mainly responsible for the cladoceran peak in late June (Fig. 1). *Evadne tergestina*, the second most abundant cladoceran, occurred in a pattern similar to that of *P. avirostris* (DELLA CROCE & ANGELINO, 1987). *Podon polyphemoides* showed a significant presence in spring and early summer and *Evadne spinifera* from late spring to early autumn (Fig. 1). Finally, *Evadne nordmanni* and *Podon intermedius* occurred for short periods in mid-late spring and winter, respectively (Fig. 1). Rapid increases due to parthenogenetic reproduction should be responsible for the sharp fluctuations in abundance of all six species. The circular mapping of the samples in the MDS plot (Fig. 2) reflects a complete annual cycle with three main groups representing three main assemblages: (a) a winter assemblage (I: 1, 2, 3, 5, 42) due to the occurrence of *P. intermedius*, (b) a spring assemblage (II: 6 to 13) due to the occurence of *P. polyphemoides* and *E. nordmanni* and (c) a summer-autumn assemblage (III) characterised by the remaining species. Taking into account that temperature varies from 13°C (February) to 25°C (August), *P. avirostris* and E. tergestina can be characterized as thermophilic, *P. intermedius* and *E. nordmanni* as stenothermic but occurring in different seasons, whereas *P. polyphemoides* and *E. spinifera* as more eurythermic species (Fig. 1).

Penilia avirostris predominated the cladoceran community; this could be related with the generally low algal biomass available in the area (CHRISTOU & VERRIOPOULOS, 1993) taking into account the organism's capability for adaptation in low levels of resources (PAFFENHOFER & ORCUTT, 1986). MORAITOU-APOSTOLOPOULOU AND KIORTSIS (1973) suggested that salinity may affect cladoceran populations. In the study area salinity exhibits very weak annual variations within a range of about 1‰. As well, cladocerans are provided with a salt gland (the nuchal organ) and can sustain a wide range of salinities (MEURICE & GOFFINET, 1982). Knowledge of feeding habits of marine cladocerans is still poor. *Penilia avirostris* has been found to feed on small particles including bacteria (e.g. PAFFENHOFER & ORCUTT, 1986). *Evadne* spp. and *Podon* spp. seem to feed largely on discrete particles and perhaps detritus (KIM *et al.*, 1989), whereas *Podon intermedius* has been reported as a raptorially-feeding herbivore (JAGGER *et al.*, 1988). Finally, gut content examination of five species of marine cladocerans revealed that feeding was largely limited to centric diatoms and a few exceptions of pennate diatoms and dinoflagellates, all smaller than 35µm in size (KIM *et al.*, 1989). In the present study temperature and food resourses can be considered as the major regulators of cladoceran annual cycle. Taking into account : (a) the effect of temperature, (b) that food in terms of chlorophyll may act as a limiting factor for zooplankton in the area (CHRISTOU & VERRIOPOULOS, 1993), and (c) the implications of cladocerans with the microbial food web, future study on the effect of the various food resources available in the area may reveal mechanisms controlling the seasonality and succession of cladocerans.

REFERENCES

CHRISTOU E.D. and VERRIOPOULOS G.S., 1993. *Mar. Biol.*, 115: 643-651.
DELLA-CROCE N. and ANGELINO M., 1987. *Cah. Biol. Mar.*, 28: 263-268.
JAGGER R.A., KIMMERER W.J. and JENKINS G.P., 1988. *Mar. Ecol. Prog. Ser.*, 43: 245-250.
KIM S.W., ONBE T. and YOON Y.H., 1989. *Mar. Biol.*, 100: 313-318.
KIORTSIS V. and MORAITOU-APOSTOLOPOULOU M., 1975. *Isr. J. Zool.*, 24: 71-74.
MEURICE J.-C. and GOFFINET G., 1982. *C. R. Acad. Sc.* Paris, T. 295: 693-695.
MORAITOU-APOSTOLOPOULOU M. and KIORTSIS V., 1973. *Mar. Biol.*, 20: 137-143.
PAFFENHOFER G.-A. and ORCUTT J.D., 1986. *J. Plankton Res.*, 8: 741-754.

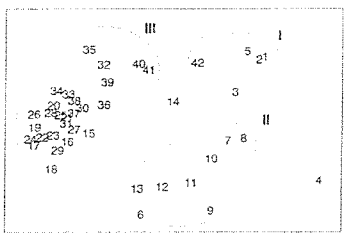


Fig. 2. MDS plot of cladoceran species abundances, Saronikos Gulf, 1989. Dates of the 42 samples are: 1=30/1, 2=20/2, 3=7/3, 4=20/3, 5=27/3, 6=3/4, 7=11/4, 8=17/4, 9=24/4, 10=2/5, 11=8/5, 12=15/5, 13=22/5, 14=29/5, 15=5/6, 16=12/6, 17=20/6, 18=26/6, 19=3/7, 20=10/7, 21=17/7, 22=24/7, 23=31/7, 24=10/8, 25=16/8, 26=22/8, 27=28/8, 28=6/9, 29=13/9, 30=23/9, 31=2/10, 32=11/10, 33=18/10, 34=24/10, 35=30/10, 36=6/11, 37=13/11, 38=20/11, 39=27/11, 40=4/12, 41=12/12, 42=27/12. From the total set of 43 samples, the one sampled on 12/1 was excluded from the analysis (absence of cladocerans). Symbols are as in Fig. 1.

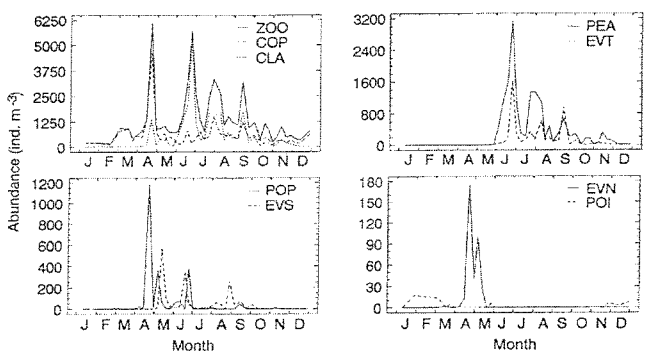


Fig. 1. Abundance (ind. m^{-3}) of total mesozooplankton (ZOO), copepods (COP), cladocerans (CLA), and the cladoceran species *Penilia avirostris* (PEA), *Evadne tergestina* (EVT), *Podon polyphemoides* (POP), *Evadne spinifera* (EVS), *Evadne nordmanni* (EVN) and *Podon intermedius* (POI), Saronikos Gulf, 1989.

ZOOPLANKTON SEASONAL VARIATIONS DURING A YEAR STUDY IN THE MAJORCAN SHELF BALEARES, SPAIN (39° 28'59 N; 2° 25'63 E)

M.L. FERNÁNDEZ de PUELLES[1], B. AMENGUAL[1], C. GOMIS [2], D. GRÁS[2], J. JANSÁ[1], A. MORILLAS[1] and L. VICENTE[1]

[1] Oceanogr. Lab. of Spain-IEO- Apdo.291, 07080 Palma, Spain
[2] Inst. Ecol. Litoral. 03560 El Campello. Alicante, Spain

Between April 1993 and April 1994 physical, chemical and planktonic samples were collected every 10 days, from a station 75 m depth, located in open area 5 miles off the south Majorca Island. The hydrographic and phytoplankton samples were taken by 3L Niskin bottles at 0, 15, 25, 50 and 75 m depth and the zooplankton samples by Bongo plankton nets, oblique hauls, with a 250 µm and 100 µm mesh, into whiche, a flowmeters General Oceanic 2030 was placed. The main goal of this paper was to describe the seasonal variation of the zooplankton communities, mesozooplankton (250 µm) and microzooplankton (>100 µm), nevertheless other oceanographic parameters were studied and related, as temperature, salinity, nutrients, chlorophyll "a" pigment and phytoplankton cells.

During the year studied, the surface temperature varied from 26.7°C in August to 13.5°C in February, with a strong thermocline, between 20 to 40 m depth, from May to November. Salinity values ranged from 36.5‰ in September to 38‰ in February, the lower values during the summer indicating the presence of waters from Atlantic origin. Excepting the bottom layer where we found higher values of nitrates all year around, it was during spring and autumn that higher concentrations appeared in the water column, in relation to higher numbers of phytoplankton cells. In average, very low concentrations were found (<20 cells/ml) with higher values always close to the bottom (50 cells/ml). Diatoms were the most abundant (80%); beside them, dinoflagellates were also important. Although, a single maximum of chlorophyll "a" was seen in January with 1.11 mg/m^3, other lower peaks were observed related to the microzooplankton community studied. Copepods nauplii (19% of numbers) and small copepods as well as copepodites (70%) mostly contributed to the microzooplankton (3.18 mg D.W/m^3) with 3884 ind/m^3, which appeared to control the pytoplankton biomass that, except in December and January, was smaller than 20 µm. The mesozooplankton was also important (7.19 mg D.W/m^3) with 1842 ind/m^3. The copepods contributed with 62% to the total numbers (*Paracalanus parvus, Clausocalanus spp., Acartia clausi, Oithona spp., Temora stylifera* and *Centropages typicus* mainly), showing a maximum in early summer, and related to the highest value of biomass (Fig.1). Nevertheless, other smaller biomassic peaks were irregularly observed and not related to the abundance of copepods, indicating that some other zooplanktonic groups (cladocera, appendicularia, etc) were more important in the area. Although, the summer maximum is not very common in open areas, it has been observed some times, in other zones of the Mediterranean (GAUDY, 1970; MARGALEF, 1989; RAZOULS and KOUWENBERG, 1993). The microzooplankton (abundance and biomass) temporal variation can be observed in Fig. 2.

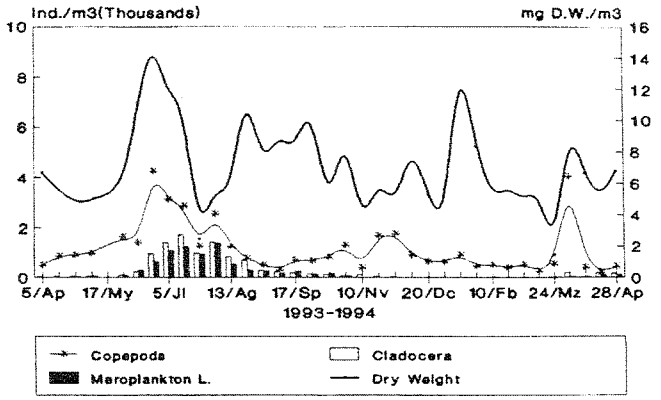


Fig. 1 : Seasonal variation of the mesozooplankton (Ap.1993 - Ap. 1994)

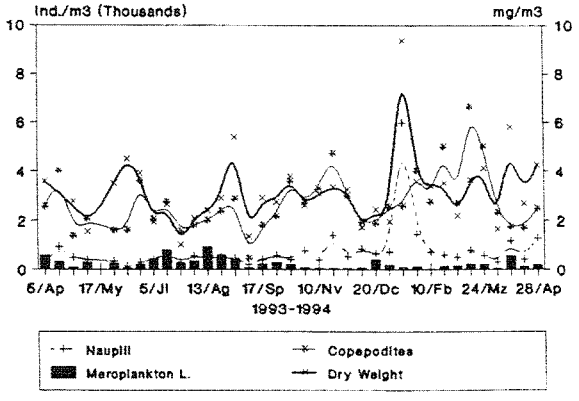


Fig.2 : Seasonal variation of the microzooplankton (Ap.1993 - Ap. 1994)

REFERENCES

GAUDY, R. 1970.- Thèse de doctorat. Univ. of Marseille, 294 pp.
MARGALEF, R.1989.- In Mediterraneo Occidental. Ed. Omega, 375 pp.
RAZOULS.C. and KOUWENBERG, H.M. 1993.- *Oceanol. Acta*, 16 : 393-401.

EUTROPHICATION ASSESSMENT BASED ON PHYTOPLANKTON COMMUNITY ANALYSIS

E. GATSIOU, G. TSIRTSIS and M. KARYDIS

Department of Environmental Studies, University of the Aegean
17, Karadoni str. 81100 Mytilini, Greece

Although multivariate methods based on nutrient and chlorophyll concentrations have been widely used for eutrophication assessment (KARYDIS, 1992), few efforts have been made for the evaluation of water quality based on phytoplankton community analysis (CLARKE, 1993). In the present work, a number of scaling methods and resemblance measures were tested, in order to maximize the discrimination between an eutrophic and an oligotrophic system. Water samples were collected from February 1992 to May 1993, on a monthly basis, from two stations, M1 and M2, in the strait of Lesvos. The first one was sampled at 1, 5 and 10 m (experimental units A), while the other was sampled at 1, 5, 10, 20 and 30 m (experimental units B). M1 and M2 were characterized as eutrophic and oligotrophic respectively, in previous work (KARADANELLI *et al.*, 1992). A mean abundance was calculated for each species, during summer (May-October) and winter (November-April), dividing the original data-set into two subsets (summer and winter); the three sampling depths of station M1 and five of station M2 formed the eight columns of the data matrix. Numerical classification of the eight sampling units was performed by the group-average clustering algorithm, based on euclidean and absolute distances and Bray-Curtis similarity measure, since they have shown efficiency in discriminating polluted sites (KARYDIS, 1992; SIOKOU-FRANGOU & PAPATHANASSIOU, 1991). Data scaling was also applied, using metric (no scaling) and binary scaling. Values of species abundance exceeding the mean value of a sample were expressed by the state 1, otherwise state 0. Elimination of the data matrices was also performed, excluding species which occurred in the sampling units less than 10 times annually. Two clusters were formed, a eutrophic and an oligotrophic, and the differences between them, were tested by the non-parametric randomization test ANOSIM (CLARKE & GREEN, 1988). The results are presented in Table 1. Phytoplanktonic community data showed good resolution between the eutrophic and oligotrophic sites in most of the cases. It was observed that the discrimination was better when the rare species were excluded, which supports the view that these species add noise to the signal carried by the phytoplanktonic community structure. The resolution between the eutrophic and oligotrophic sites was almost the same, either using metric or binary scaling; similar classification trends were shown by both euclidean and absolute distances. The best discrimination, both in the summer and winter period, was achieved using the Bray-Curtis coefficient of resemblance, on the reduced data matrix with no scaling of the original values (Figure 1).

	Metric	Binary
I. Summer period		
A. Species elimination. all species considered		
	Scales	
B.C.	0.797*	0.345
E.D.	0.705*	0.698*
A.D.	0.673*	0.698*
B. Species elimination: rare species excluded		
	Scales	
B.C.	0.806*	0.286
E.D.	0.721*	0.906*
A.D.	0.673*	0.906*
II. Winter period		
A. Species elimination: all species considered		
	Scales	
B.C.	0.894*	0.400
E.D.	0.667*	0.523*
A.D.	0.667*	0.523*
B. Species elimination: rare species excluded		
	Scales	
B.C.	0.903*	0.318
E.D.	0.667*	0.670*
A.D.	0.667*	0.670*

Tab. 1. ANOSIM test significance levels for differences between clusters (B.C. Bray-Curtis similarity measure, E.D. and A.D. euclidean and absolute distances, respectively).
** Statistically different clusters at the 0.05 probability level..*

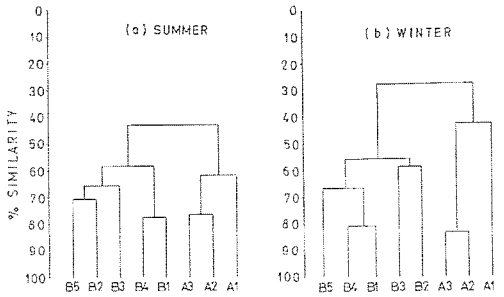


Fig.1. Dendrograms for group average clustering of the reduced data matrix with the Bray-Curtis coefficient in summer (a) and winter (b) period; (A1, A2, A3 and B1, B2, B3, B4, B5, represent different depths of the eutrophic and oligotrophic stations, respectively).

Numerical classification by the group average clustering algorithm, based on phytoplanktonic community data seems to be an efficient method to assess water quality. As a conclusion, the following stepwise procedure is proposed: a) reduction of the original data matrix by removing the rare species, b) no scaling of the original data values, c) use of the Bray-Curtis coefficient of resemblance, d) identification of distinct groups of sites with objectivity by the non-parametric randomization test ANOSIM.

ACKNOWLEDGEMENTS. The present work was supported by a WHO/UNEP grant (Project ICP/CEHO42).

REFERENCES

CLARKE, K.R., 1993. Non-parametric multivariate analyses of changes in community structure. *Australian Journal of Ecology*, 18 : 117-143.

CLARKE, K.R. and GREEN, R.H., 1988. Statistical design and analysis for a "biological effects" study. *Mar. Ecol. Prog. Ser.* 46 : 213-226.

KARADANELLI, M., MORIKI, A., FARIDIS, E. and KARYDIS, M., 1992. Annual pattern of heterotrophic bacteria and phytoplankton in a nitrogen rich coastal system. *Rapp. Comm. Int. Mer. Medit.* 33 : 198.

KARYDIS, M., 1992. Scaling methods in assessing environmental quality: A methodological approach to eutrophication. *Env. Monitoring and Assessment*, 22 : 123-136.

SIOKOU-FRANGOU, I. and PAPATHANASSIOU, E., 1991. Differentiation of zooplankton populations in a polluted area. *Mar. Ecol. Prog. Ser.* 76 : 41-51.

THE PHYTOPLANKTON CYCLE IN THE SOUTH-WEST OF THE MAJORCAN SHELF (BALEARIC ISLANDS) : SEASONAL DISTRIBUTION

C. GOMIS[1] & M. L. FERNÁNDEZ DE PUELLES[2].

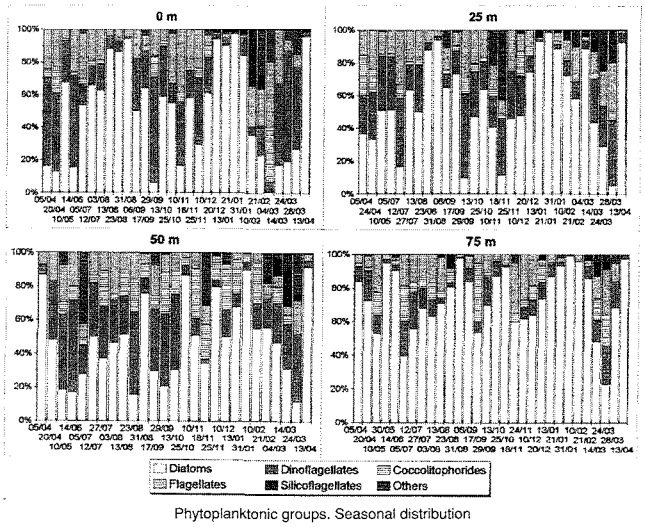
[1]Institut d'Ecologia Litoral. C/Benimagrell, 5. 03560-El Campello, Alicante, Spain
[2] Oceanogr. Lab. of Spain-IEO. Apdo. 291. 07080-Palma, Spain

The purpose of this paper is to show the phytoplanktonic results of the HERCULE project planktonic study carried out at a sampling station situated in the southwest of Mallorca Island (39°28'59 N; 2°25'63 E). Samples were collected every 10 days approximately from a station 75 m depth and 5 miles off the coast, between April 1993 and April 1994. The main aim of this paper is to describe seasonal variation of the phytoplankton communities, nevertheless other oceanographic parameters have been studied and related as temperature, salinity, nutrients and chlorophyll "*a*" pigment. The phytoplankton samples were collected using a hydrographical bottle (Niskin 5 l) at 0, 15, 25, 50 and 75 m depth. The collected organisms were fixed in a 2% formaldehyde solution. The method used is the Utermöhl method (SOURNIA, 1978). However, it only shows the data corresponding to 0, 25,50 and 75 m depth.

During the year of our study the surface temperature varied from 26°7 C in August to 13°5 C in February, observing from May to November a strong thermocline between 20 and 40 m depth. Salinity values ranged from 36.5‰ in September to 38.0‰ in February. The higher values of -NO3 appeared during spring and autumn, with the exception of the bottom where higher values were found all year round. Furthermore a single maximum chlorophyll "*a*" was seen in January (1.11 mg/m^3), in relation to higher numbers of phytoplankton cells. The highest diversity (upper to 3.0-3.5 Bits) was common during the year of our study. The cellular abundance was reduced considerably throughout the year. The highest cellular concentrations were reached at the deepest level (75 m, they never exceeded 70 cells/ml). In the upper levels the amounts range between 4-40 cells/ml, excepting the surface layer where we found higher values (65 cells/ml in January, in relation to large colonial species of genus: *Chaetoceros, Thalassiothrix, Rhizosolenia, Bacteriastrum* and *Nitzschia*).

The colonial diatoms are the main phytoplanktonic group; it was during winter that higher concentrations appeared (occasionally up to 90% of community). *Nitzschia pungens, Nitzschia fraudulenta* and *Thalassiothrix frauenfeldii* dominate among the pennates. *Leptocylindrus danicus, Rhizosolenia stolterfothii, Rh. fragilissima* and great quantity of species of genus *Chaetoceros* dominate among the centrics (mainly during spring and winter). In summer a maximum of colonial diatom *L. danicus* was observed in the water column (values ranging from 18 cells/ml in surface to 50 cells/ml in the bottom layer). The diatoms are more than 85% of all the individuals observed throughout the year at the deepest level; similar situations have been observed in other nearby areas of the Mediterranean sea (MARGALEF, 1989). Dinoflagellates present important percentages at the surface levels (values ranging between 15-60% of the total community) reaching their highest diversity and abundances at the beginning of the summer and the middle of autumn. Usually they coincide with the periods of smaller cellular concentration (abundances around to 4-10 cells/ml). Several species of the genus *Oxytoxum, Ceratium* and *Alexandrium* are constantly present throughout the year. The rare noctilucal *Kofoidinium velelloides* appears frequently in the depth as was noted by other authors (BALECH, 1988). A lot of cyst forms of dinoflagellates appear at depths of 50 and 70 m, sometimes difficult to recognize. Coccolithophorids and silicoflagellates reach their maximum at the deepest levels. *Calciosolenia murrayi, Discosphaera tubifera* and *Rhabdosphaera clavigera* are common at these levels, particularly the first one, at times reaching 15% of the species present. The most abundant silicoflagellate is *Dyctiocha fibula* mostly during winter (at the surface, values of 15% of the community total are reached).

Finally the presence of species of different groups (cyanophytes, cryptomonadals, etc.) occurs occasionally, but it is not strange to find them at the 50 and 75 m levels. The genus Synechocystis reaches important abundances during the winter months at the 50 m level, and the genus Spirulina regularly appears at the 75 m level.



Phytoplanktonic groups. Seasonal distribution

REFERENCES

BALECH, E. 1988. Los dinoflagelados del Atlantico Sudoccidental. *Boll. Inst. Esp. Oceanogr.* 1: 1-310.

MARGALEF, R. 1989. El Mediterráneo Occidental. Barna. Ed. Omega.

SOURNIA. A. 1978. Phytoplankton Manual. UNESCO. Monogr. Oceanogr. Methodol.

P

SEASONAL VARIABILITY OF PHYTOPLANKTON IN EUTROPHIC AND OLIGOTROPHIC ENVIRONMENTS IN SARONIKOS GULF, GREECE, 1983-1985

Olympia GOTSIS-SKRETAS

National Centre for Marine Research, 16604 Hellenikon, Athens, Greece

From June 1983 to December 1985 and several times a year, surface water samples were collected with a 1.3 l N.I.O. bottle at two locations in the western Saronikos Gulf. Station S1 (38°00.3 N - 23°26.9 E), located in Elefsis Bay, is typical of a strong eutrophic environment and station S2 (37°44.8 N - 23°22.1 E), located in the outer Saronikos, is characterized by almost oligotrophic conditions (FRILIGOS, 1985). Phytoplankton samples, after fixation with Lugol's solution, were examined under an inverted microscope. The aim of this study is to present the seasonal phytoplankton abundance and species composition in these two different environments. At station S1, diatoms, dinoflagellates and µ-flagellates (flagellates with cell diameter less than 5 µm) were always present in large amounts (Table 1 and Fig. 1). Coccolithophores afforded very few species, but gave a bloom in July 1983 and July 1985. Silicoflagellates appeared only occasionally and always in very small quantities. On the average, the microplankton (total of all phytoplankton groups with cell diameter larger than 5 µm) had the lowest cell density in February (2.7×10^4 cells.l-1) and the highest in July (4.1×10^6 cells.l^{-1}). The µ-flagellates tended to have a minimum abundance in December (4.0×10^4 cells.l^{-1}) and a maximum in May (6.8×10^6 cells.l^{-1}). The number of species was by far more constant (average: 30 species per 10-ml sample). It did not display any pronounced seasonal trend or correlation with the number of individuals. Station S2 differs, as the phytoplankton density was at least one order of magnitude lower than it was at S1 (Table 1 and Fig.1), with average values of microplankton and µ-flagellates 4.6×10^4 cells.l^{-1} and 1.4×10^5 cells.l^{-1}, respectively. Also, the microplankton tended to have the normal seasonal cell variation, with a minimum in December-January and also in May, and a maximum in March.The abundance of µ-flagellates had a minimum in September and a maximun in spring months. Furthermore, the number of species displayed the usual trend of increasing with the number of individuals. The concentration of total dissolved inorganic nitrogen ÔN (nitrite, nitrate, ammonium) is higher at S1 (aver.: 2.94 µM.l^{-1}) than at the S2 (aver.: 1.03 µM.l^{-1}). Based on the species that were most important in abundance during the study period, five different assemblages were distinguished in phytoplankton community at station S1. The first assemblage, comprising the species *Coscinosira polychorda, Chaetoceros curvisetus, Thalassiosira rotula, Thalassiothrix mediterranea, Chaetoceros socialis* and *Chaetoceros didymus* was detected in December and February. From March to April, phytoplankton consisted of the species *Eucampia zodiacus, Scrippsiella trochoidea, Prorocentrum micans, Nitzschia seriata, C. curvisetus* and *Phalacroma pulchellum.* The third assemblage appeared in May-June and was made up of the algae *Gymnodinium sp., Leptocylindrus minimus, Nitzschia closterium, Leptocylindrus danicus* and *Skeletonema costatum.* In July 1983 and July 1985, a bloom of *Emiliana huxleyi* was observed, with densities of 2.1×10^6 cells.l^{-1} and 3.1×10^6 cells.l^{-1}, constituting 70.5% and 76.4% of the whole microplankton population, respectively. By the end of August to November, phytoplankton mainly consisted of the species *N. closterium, L. minimus, Rhizosolenia fragilissima, C. curvisetus, Chaetoceros glandazii* and *E. huxleyi.* At station S2, for most of samplings, the species composition and succession resembled those at S1. Also, the variations in diversity were quite intensive at S1, where the lowest values were recorded during the Coccolithophore blooms, while at the outer station S2, the diversity values were relatively high,reaching values of 3.4 bits/indiv.

	STATION S1		STATION S2	
TAXONOMIC GROUP	RANGE	AVERAGE	RANGE	AVERAGE
DIATOMS	2.0×10^4-1.1×10^6	3.4×10^5	5.0×10^2-1.9×10^5	4.1×10^4
DINOFLAGELLATES	1.8×10^3-3.8×10^5	1.0×10^5	2.0×10^2-1.4×10^4	3.8×10^3
COCCOLITHOPHORES	2.0×10^2-3.1×10^6	3.1×10^5	0-3.3×10^3	6.3×10^2
SILICOFLAGELLATES	0-1.2×10^3	1.2×10^2	0-1.0×10^3	1.4×10^2
MICROPLANKTON	2.7×10^4-4.1×10^6	7.6×10^5	8.0×10^2-2.0×10^5	4.6×10^4
µ-FLAGELLATES	4.0×10^4-6.8×10^6	1.4×10^6	4.8×10^3-4.7×10^5	1.4×10^5

Table 1. Ranges and average values of phytoplankton (cells.l^{-1}) at S1 and S2, from June 83 to Dec. 85.

In conclusion, the impact of human activity resulted in that the peak of microplankton abundance occurred in summer and not in March. Furthermore, pollution tended to reduce the number of species when the abundance soared, while, in natural conditions, the number of species increases with the number of individuals. In addition, *E. huxleyi* and *R. fragilissima*, predominating at S1, do not appear among the first five species at station S2, which presented about one tenth of diatoms and microplankton and about half the number of the species in comparison to S1, among which *N. closterium* and *L. danicus* predominated. This suggests that pollution causes the bloom of few species, which depend on the local conditions and are scanty in clean waters. The above mainly quantitative differences between the two stations, which are also qualitative in several cases, confirm the eutrophic character of the Elefsis area, but also the oligotrophic conditions which dominate at the western Saronikos. Similar results have been reported by MORAITOU-APOSTOLOPOULOU & IGNATIADES (1980), and PAGOU (1986) in similar studies of Saronikos Gulf.

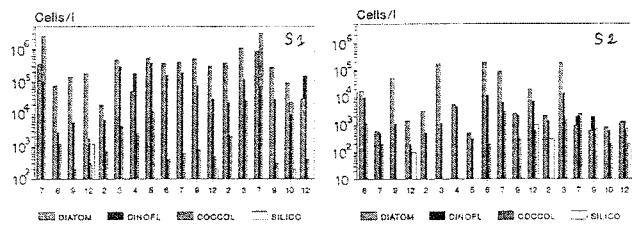


Fig. 1. Abundance variation of phytoplankton groups at the stations S1 and S2.

REFERENCES

FRILIGOS N., 1985. *Water Res.*, 19 : 1107-1118

MORAITOU-APOSTOLOPOULOU M. and IGNATIADES L. 1980. *Hydrobiologia* 75 : 259-266.

PAGOU K., 1986. *Rapp. Comm. int. Mer Medit.*, 30(2): 191.

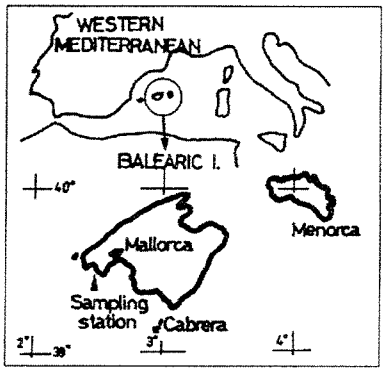
FAUNISTIC STUDY OF THE MESOZOOPLANKTON FROM THE SOUTH-WEST OF MALLORCA (BALEARIC ISLANDS)

David GRAS[1], Christian GOMIS[1] and M. Luz FERNÁNDEZ DE PUELLES[2]

[1] Institut d'Ecologia Litoral. C/Benimagrell, 5.03560. El Campello (Alicante), Spain

[2] I.E.O. Centro Oceanográfico de Baleares. C/Muelle de Poniente, Mallorca, Spain

This paper shows the faunistic results of the HERCULE project planktonic study carried out in a sampling station placed south-west of Mallorca (Fig.). This study tries to contribute to the project goal, bringing information about hydrography and planktonic dynamics from whole Mediterranean Sea. The hydrographical and phytoplanktonic results are showed in the other two papers (FERNÁNDEZ DE PUELLES *et al.*, 1995; GOMIS and FERNÁNDEZ DE PUELLES, 1995). The zooplankton samples were got using Bongo net hauls provided with a 20 cm mouth diameter and 250 µm mesh-size. The sampling was done every ten days during an annual cycle (April 93–April 94). Two kinds of hauls were carried out in each sampling : a horizontal–superficial and an oblique (from -75 m approximately to surface). The collected organisms are fixed in a 4% formaldehyde solution buffered with hexamethylenetetramine. The use of sub–sampling methods makes easy the zooplankton identification and count (Table 1):



Location of the sampling station

- 1. The highest qualitative and quantitative participation of total occurs in the summer, when the availability of phytoplankton persists.
- 2. The zooplanktonic community is characterized by the presence of a perennial species group: copepods *Paracalanus parvus, Clausocalanus spp., Acartia clausi, Oithona nana, Oithona helgolandica,* immature individuals of the chaetognath *Sagitta* and the larvacean *Oikopleura dioica.* Every one of them is quoted as common epiplankton of the Western Mediterranean Sea.
- 3. Seasonal organisms add to the community in the course of the year : **summer:** case of cladocerans and the copepod *Temora stylifera* (observed during the longer part of the year, their presences are scarce in the winter samples), the doliolid *Doliolum nationalis* and molluscs (holo- and meroplanktonic species). Their observations occur in summer preferably because they are thermophile organisms; **autumn and spring** : the larger part of meroplanktonic larvae (decapods and polychaete larvae), in accordance with their planktotrophic characteristics; **winter** : abundance of the copepods *Centropages typicus* and *Isias clavipes.*
- 4. And a occasional species group is observed in the community. Their presences depend on the kind of haul (deep organisms such as ostracods *Conchoecia* in the oblique haul and Pontellidae hyponeustoniccopepods in the surface haul) and climatic conditions (allochtonous species coming from oceanic holoplankton carried away by the storms, case of amphipods Hyperiidea). In this way, the larvae of brief planktonic live can be considered occasional, such as the Phoronids Actinotrocha.

	FAUNISTIC GROUP	ZOOPLANKTONIC SPECIES	S		M		A		W	
			o	h	o	h	o	h	o	h
HOLOPLANKTON	Cladocerans	Penilia avirostris Dana, 1849	4	3	4	4	4	3	1	1
	Cladocerans	Evadne spinifera Müller, 1868	4	4	4	4	4	3	1	1
	Copepods	Calanus helgolandicus (Claus, 1863)	2	1	1	1	2	2	3	3
	Copepods	Paracalanus parvus (Claus, 1863)	4	4	3	3	4	4	3	3
	Copepods	Clausocalanus spp.	4	4	3	3	4	4	3	3
	Copepods	Temora stylifera (Dana, 1848)	3	3	3	3	3	3	2	2
	Copepods	Centropages typicus Kröyer, 1848	3	3	2	2	3	3	3	3
	Copepods	Isias clavipes Boeck, 1864	2	2	-	-	2	2	3	3
	Copepods	Labidocera wollastoni (Lubbock, 1857)	1	2	-	2	1	1	-	-
	Copepods	Acartia clausi Giesbrecht, 1889	3	3	3	2	3	3	2	2
	Copepods	Oithona nana Giesbrecht, 1892	3	3	3	2	3	3	2	2
	Copepods	Oithona helgolandica (Claus, 1863)	3	3	3	2	3	3	2	2
	Ostracods	Conchoecia spp.	1	-	1	-	1	-	2	-
	Amphipods	Hyperiidea	1	-	-	-	-	-	1	-
	Molluscs	Creseis acicula Rang, 1828	2	2	3	3	2	2	-	-
	Molluscs	Limacina spp.	3	3	3	3	3	3	1	-
	Chaetognaths	Sagitta spp. (immature individuals)	2	2	2	2	2	2	2	2
	Larvaceans	Oikopleura dioica Fol, 1872	3	3	2	2	3	3	2	2
	Doliolids	Doliolum nationalis Borgert, 1894	2	2	3	3	2	2	-	-
MERO	Polychaete	Nectocheta Larvae	2	2	-	-	2	2	1	1
	Decapods	Zoea Larvae	3	2	2	1	2	2	-	-
	Molluscs	Veliger Larvae	3	3	3	2	2	2	-	-
	Phoronids	Actinotrocha Larvae	1	-	-	-	1	-	-	-

Table 1. Participation of the most common zooplanktonic organisms.

Abundance groups: **1**/ 0 – 10 individuals/10 m^3; **2**/ 10 – 100 individuals/10 m^3; **3**/ 100 – 1 000 individuals/10 m^3; **4**/ more than 1 000 individuals/10 m^3.

Legend: **S**, spring. **M**, summer. **A**, autumn. **W**, winter. **o**, oblique haul. **h**, horizontal and superficial haul.

REFERENCES

FERNANDEZ DE PUELLES, M.L. *et al.*, 1995. Zooplankton seasonal variations during a year study in the Majorcan shelf (Baleares, Spain) (39°28'59 N; 2°25'63 E). *Rapp. Comm. int. Mer Médit.* 34.

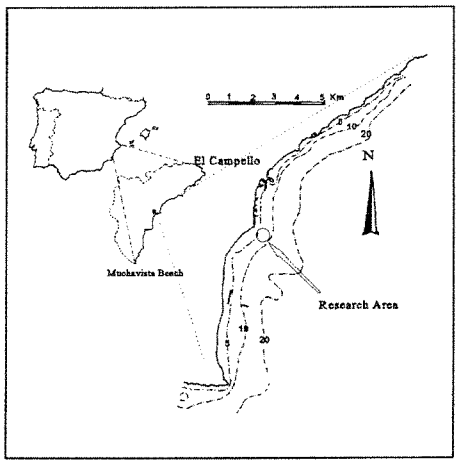
GOMIS, C. and FERNANDEZ DE PUELLES, M.L., 1995. The phytoplankton cycle in the south-west of the Majorcan shelf (Balearic Islands): seasonal distribution. *Rapp. Comm. int. Mer Médit.* 34.

ANNUAL CYCLE OF DECAPOD LARVAE ASSOCIATED WITH A SANDY BEACH IN SOUTHEASTERN OF SPAIN

J.E. GUILLÉN and D. GRAS

Institut d'Ecologia Litoral. C/Benimagrell 5. 03560. El Campello. Alicante, Spain

The research area is placed in Muchavista Beach (El Campello), located on the Southeastern coast of Spain (fig.1). The bionomic composition of this beach mainly consists of sandy bottom biocoenosis and small *Cymodocea nodosa* meadows. The research period was from July 1990 to July 1991. Samples were taken in the neritic zone, between eight and one meter depth, with a planktonic net (250 µm mesh size), and were quantified with a digital flow-meter. During the sampling period, the dominant species in decapod meroplankton were zoeas and megalopas from the following groups: (a) *Polybiinae* group (26.04%), (b) *Hippolytidae* family (15.73 %), (c) *Portumnus latipes* (13.00 %), (d) *Philocheras* sp. (11.78 %), (e) *Processa* sp. (9.42 %), and (f) *Diogenes pugilator* (8.05 %).



If we compare the composition of neritic larvae population with that of adult populations during the same period, we can see that the dominant taxa are the same in both cases. Dominant adults in the study area are: *D. pugilator* (40.85%), *Philocheras monacanthus* (25.12%), *Macropodia rostrata* (14,6%), *Hippolyte inermis* (12.07%) and *Liocarcinus vernalis* (2.8%) (GUILLÉN & PÉREZ, 1993).

Due to the fact that it is very difficult to determine larvae, mainly to get species level, there is very little specific literature on the subject. This fact makes it almost impossible to make any relationship between larvae and adults. This problem even gets worse with larvae of Polybiinae and Hippolytidae, because several species are included in these groups.

The research carried out revealed that the larvae and adult populations found in the area are closely related to each other, such is the case of the larvae that could be determined to species level, viz., *D. pugilator*. In this way, we can consider that many *Philocheras* sp. and *Processa* sp. larvae are the same than the benthic adults found, viz., *P. monacanthus* and *P. modica carolii* respectively. And therefore, larvae considered as *Polybiinae* and *Hippolytidae* may contain a considerable percentage of the main species found in this research, that is, *L. vernalis* and *H. inermis* respectively.

However, the abundance of *P. latipes* larvae contrasts with the lack of adults. This fact could be clarified by means of the bathymetric range of *P. latipes* (0-2 meters). This area was not sampled during the research period. This absence of relationship between larvae and adult populations is also seen in *M. rostrata* of which no larvae were found, and in Majidae of which just two specimens were identified as such. When comparing the seasonal composition of decapod larvae, some differences can be pointed out :

Summer : Larvae composition is equally distributed. However, some species can be considered as dominant, such as Hippolytidae group (26%), and the Polybiinae group, probably *Liocarcinus* sp. (25%), and *P. latipes* (11%). The latter mainly reproduces during the summer period. In this season, we have also found *D. pugilator* (10%), and at percentages lower than 10%: *Calcinus tubularis, Porcellana platycheles, Pirimela denticulata, Processa* sp., *Callianassa* sp, *Ebalia* sp., *Eurynome* sp. and species included as Caridea, Alpheidae, Majidae, and non identified Brachyura.

Autumn : Polybiinae group still dominates in the samples obtained (37%). But, the variety is lesser than the one observed during the summer. This fact can be due to a *Philocheras* sp. larvae bloom (39%). We have also detected Hippolytidae larvae, *P. latipes, D. pugilator*, and a group of unidentified Brachyura (8%). The remaining taxa are *Dromia personata* and Alpheidae, and stand for the 2%.

Winter : Although the number of larvae was low, the samples taken at the end of this period (March) dominated the number of samples taken during the winter. Thus, *Processa* sp. (40%) is the main species, due to the start of its reproductive period. *Processa* sp. is immediately followed by *Philocheras* sp. (17%), by *Polybiinae* group (14%) and by *Galathea intermedia* (8%) that also start their reproductive period. There are seven other taxa with percentages lower than 2%: *Processa* sp., unidentified Caridea, *P. platycheles, P. denticulata, P. latipes, Gennadas elegans* and Majidae.

Spring : The species with high fecundity gives rise to high larvae percentages, like Polybiinae group (31%) and *P. latipes* (43%). At this time of the year, *D. pugilator* starts its reproduction season (10%). We also point out the decrease of larvae of *Processa* sp. and *Philocheras* sp., contrasting with the high percentage observed during the winter period.

Finally, we must underline the high number of larvae from neritic zone species, and the low percentage (0,3%) of oceanic species (only *G. elegans*). Thus, we can say that the dominant taxa found are the same than those of the dominant species from local benthic communities (GUILLÉN & PÉREZ-RUZAFA, 1993).

REFERENCES

GUILLÉN, J.E. & PÉREZ-RUZAFA, 1993. Composición, estructura y dinámica de poblamientos de crustáceos decápodos asociados a las comunidades arenosas del SE ibérico. *Publ. Espec. Inst. Esp. Oceanogr.* 11 : 175-183.

WINTER DISTRIBUTION OF COPEPODS IN THE SOUTH ADRIATIC SEA

Edmond HAJDERI[1], Nicola CASAVOLA[2], Giovanni MARANO[2]

[1] Fakulteti i Shkencave Natyrore, Universiteti i Tiranes, Tirana, Albania

[2] Laboratorio Provinciale di Biologia Marina, Bari, Italy

Data about the epipelagic copepods of the Southern Adriatic Sea, collected in the coastal and offshore waters, are reported in this paper. The zooplankton has been collected in 20 stations situated along 5 transects on the bathymetrics of the 50, 100, 200 and 500 meters in the Apulian Adriatic waters during a research aiming at evaluating the Clupeiforms ichthyoplankton (fig.1). Samples were obtained by double oblique hauls using a "Bongo 60" net with 235 µm mesh size. The data have been elaborated through multivariate analysis using Bray-Curtis index of similarity. In the whole area 74 species of copepods have been determined, however 17 are the ones which represent 95% of population (tab.1).

Clausocalanus pergens	20,7	*Clausocalanus jobei*	2,6
Acartia clausi	19,3	*Calanus helgolandicus*	2,5
Ctenocalanus vanus	9,7	*Calanus tenuicornis*	2
Paracalanus parvus	9,2	*Oithona plumifera*	1,3
Oithona atlantica	6	*Calocalanus styliremis*	1,3
Centropages typicus	5,5	*Pseudocalanus elongatus*	1,1
Temora longicornis	3,5	*Clausocalanus arcuicornis*	1,1
Clausocalanus paululus	3,4	*Clausocalanus furcatus*	1
Oithona similis	2,8		

tab.1 : Percentage (%) of the most important species.

From the cluster analysis (fig.2) two groups of stations (G1 and G2) are distinguished at 30% level of similarity. The first group (G1), which includes the stations of the first transect (st.1-4) and the stations nearest to the coast situated on the bathymetrics of 50 and 100 m (st.5, 9, 13, 17, 6, 10), is characterized by the presence of typical coastal species as *Acartia clausi* (28,3%), *Paracalanus parvus* (14,5%) and *Centropages typicus* (13,1%). The separation of the stations 1 ,2, 3 and 4 at 35% level of similarity is due to the major presence in these waters of *Ctenocalanus vanus* (28%), *Oithona atlantica* (22,3%) and *A. clausi* (19%). The second group (G2) is composed of the two most southern stations of the 100 m bathymetrics (st.14, 18) and all the other stations situated on the 200 m and 500 m bathymetrics (st. 7, 8, 11, 12, 15, 16, 19, 20). The stations belonging to this group are distinguished by the dominance of open waters species like *Clausocalanus pergens* (48,6%), *Clausocalanus paululus* (6%), *Oithona atlantica* (3,7%), *Clausocalanus arcuicornis (3,7%)* and the presence of other neritic species as *P. parvus* (7,9%), *C. vanus* (5,3%), *Oithona similis* (4,9%). The separation of stations 16, 18 and 19 at 40% level of similarity is due to the higher frequency of *C. paululus* (16,6%; 130 ind./m^3) while the station 20 is distinguished for the maximum presence of *C. pergens* (57,7%; 403 ind./m^3). It can be highlighted that *C. pergens* and *C. paululus*, considered by HURE *et al.*, 1980 as two typical species of the superficial waters of the Adriatic "oceanic community", within the most southern area of the basin extend their areal of distribution even in the neritic-coastal waters, favoured by the low winterly temperatures of the same. They continue to characterize the epipelagic open waters copepods population in the Southern Adriatic Sea. *O. atlantica* FARRAN 1908, an open waters species (NISHIDA, 1985) already found in the Otranto Channel as well (HAJDERI *et al.*, 1993), which has been never signaled before by other authors for the Adriatic Sea (HURE *et al.*, 1969, 1980; REGNER, 1985), is reported for the first time in the Southern Adriatic Sea with density values between 0,8-183,3 ind/m^3. Furthermore other four new species for the Adriatic Sea have been found : *Calocalanus tenuis* FARRAN 1926, *Centropages bradyi* WHEELER 1899, *Scolecithrix auropecten* GIESBRECHT,1892 and *Candacia giesbrechti* GRICE & LAWSON 1977. They are rare species, mostly found in the Western Mediterranean (particularly the first three ones), which probably enter the Adriatic Sea through the current of the atlantic superficial waters that in winter moves from the Central Mediterranean towards the Adriatic (ZORE-ARMANDA, 1969).

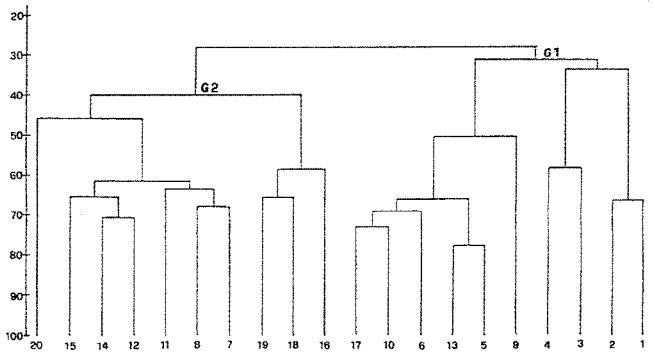


Fig.2 : Stations affinity

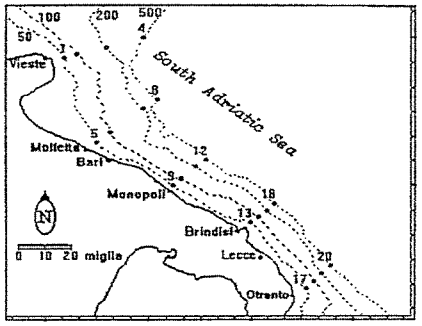


Fig.1 : Map of sampling stations

REFERENCES

HAJDERI E., CASAVOLA N., MARANO G., 1993.- *Biol. Mar. Medit*, vol. I, (1): 113-118.

HURE J., SCOTTO DI CARLO B., 1969.- *Pubbl. Staz. Zool. Napoli* 37, 2°suppl.: 173-195.

HURE J., IANORA A., SCOTTO DI CARLO B., 1980.- *J. Plankt. Res.*, 2(4): 295-316.

NISHIDA SH., 1985.- *Bull. Ocean Res. Inst. Univ. Tokyo*, 20: 122-127.

REGNER D., 1985.- *Acta Adriat.*, 26(2):11-99.

ZORE-ARMANDA M., 1969.- *Deep-Sea Research*, 16: 171-178.

P

SEASONAL VARIABILITY OF CHLOROPHYLL *A* CONCENTRATION IN THE WATER COLUMN OF MALIA BAY (SOUTH AEGEAN SEA)

Ioannis KARAKASSIS and Snezana ZIVANOVIC

Institute of Marine Biology of Crete, P.O. Box 2214, 710 03 Heraklion, Greece

In order to study the seasonal variability of the chlorophyll *a* concentrations in the water column of the coastal system in Crete, five sampling cruises of the "R/V Philia" were conducted in Malia bay in November 1992 and March, May, August and November 1993. Samples were collected at three transects (MX2, MX4, MX7) perpendicular to the coast line (Fig.1) each one including three stations (A, B and C) at depths of 10, 30 and 70 m respectively. The number of samples per station ranged from two at the 10 m depth stations (at 0 and 10 m from the sea surface), to four at the 30 m depth stations (0, 10, 20 and 30 m from the surface), and five at the 70 m depth stations (0, 10, 20 30 and 50 m from the surface). Water samples, collected by 5 l Niskin bottles, were filtered on board through Whatman CF/F filters which were subsequently stored at -20°C, and analysed for chlorophyll *a* and phaeopigments with a Turner fluorometer (YENTSCH and MENZEL, 1963). Analyses for nutrients concentration were performed after STRICKLAND and PARSONS (1972). The vertical profile of temperature, salinity and dissolved oxygen at each sampling station was obtained by means of CTD measurements. The results of the chlorophyll *a* analysis revealed rather high concentrations in March 1993 (Fig.2) which exceeded by 10 times those measured at the same stations in all other seasons. The maximal and minimal values recorded per month respectively were: 0.05-0.57 µg/l in November 1992, 0.90-4.90 µg/l in March 1993, 0.08-1.13 µg/l in May, 0.06-0.72 µg/l in August and 0.09-0.53 µg/l in November 1993. The same holds true for phaeopigments which showed a more or less similar pattern.

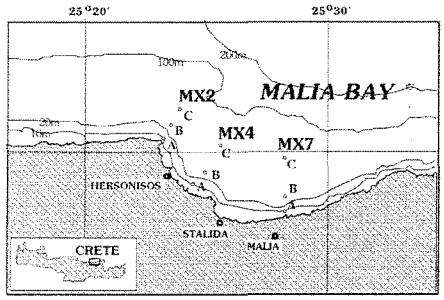


Fig. 1. Sampling stations in Malia Bay

As far as the vertical distribution is concerned, the highest concentrations during late spring and summer were found below the thermocline (30-40 m), while in November and March the distribution of phytoplankton in the water column was more or less uniform. In November 1993 however, the prolongation of the hot season resulted in a vertical distribution similar to that of the August. Phytoplankton biomasses seem to be influenced by the hydrodynamic pattern in the bay and the nutrients availability. The gradual development of the water stratification (late spring to autumn) inhibits photosynthesis due to nutrients depletion in the surface layer while during winter and early spring, mixing of the surface layers with deep, nutrients rich water masses, as well as the increase in precipitation influencing the coastal zone, form favourable conditions for the phytoplankton bloom. Figure 3 shows a considerably higher phosphate concentrations found in March at all depths. This is particularly important for Eastern Mediterranean marine ecosystems where phosphorus is a limiting factor for phytoplankton development.

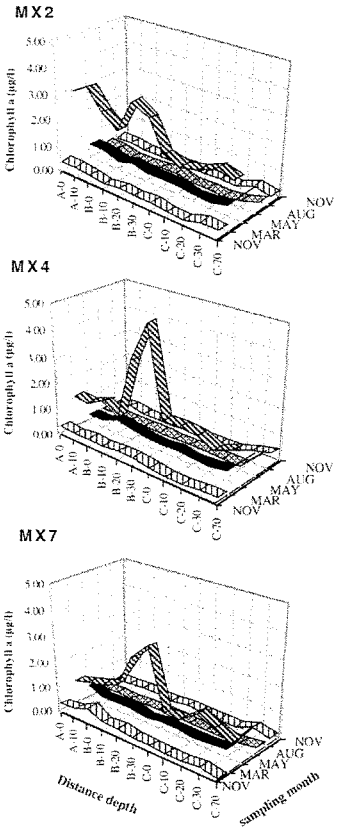


Fig. 2. Seasonal variability of chlorophyll a concentration in 3 transects, differents depths and distance from shore.

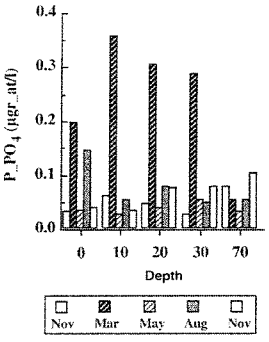


Fig. 3. Average seasonal concentration of phosphates in the water column at different depths.

REFERENCES

YENTSCH C.S. and MENZEL D.W., 1963. A method for the determination of phytoplankton chlorophyll and phaeophytin by fluorescence. *Deep Sea Res.*,10 : 221-231.

STRICKLAND J.D.H. and PARSONS T.R., 1972. A practical handbook of seawater analysis. *Fish. Res. Bd. Canada. Bulletin* 167, 310 pp.

STAGE STRUCTURE OF CHAETOGNATHS IN UPPER PELAGIC WATERS OF THE EASTERN MEDITERRANEAN IN AUTUMN 1991 AND SPRING 1992 (POEM – BC CRUISES)

G. KEHAYIAS, N. FRAGOPOULU, J. LYKAKIS

Section of Animal Biology, Depart. of Biology, Univ. of Patras, 26110 Patra, Greece.

Within the framework of the International POEM-BC programme zooplankton, samples were collected by the Greek POEM-BC group in autumn (late October to early November) 1991 and in spring (late March to early April) 1992. Samples were taken with a WP–3 closing net (mouth area 1m^2, mesh size 200 µm) towed vertically from 300 m to the surface, from fourteen stations in Eastern Mediterranean upper pelagic waters, situated along three transects, A : Cretan Sea, B: Cretan Passage and C: Rhodes Sea (Fig.1). All chaetognath specimens were sorted from the samples and identified to species and stage of development using a modification of GHIRARDELLI's (1961) system (KEHAYIAS *et al.*, 1992). The purpose of this study was to investigate differences in the stage structure, as (%) occurence of each stage of development, for each species between the two sampling periods. The abundance of the total chaetognaths was almost the same in autumn and spring (103.4 n/100 m^3 and 110.6 n/100 m^3 respectively). The chaetognath community comprised eight species (KEHAYIAS *et al.*, 1993). In autumn, diurnal vertical migration was not detected in any of the species nor in their developmental stages (KEHAYIAS *et al.*, 1994), while in spring it was only detected in *Sagitta serratodentata atlantica*. No differences in the stage structure of the species were found in the Cretan Sea, Cretan Passage and Rhodes Sea for both sampling periods tested separately (Kruskal–Wallis test, $p > 0.05$), i.e. each species was at the same phase of its reproductive cycle in the overall sampling area. The computations were performed on stage proportions using the counts of each stage within each sample. Differences in the stage structure between the two seasons were observed in all species except *S. minima* and *S. lyra* (one way anova, $p < 0.05$).

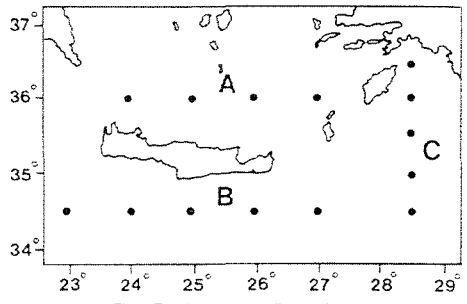


Fig. 1 Zooplankton sampling stations.

The epipelagic species *Sagitta serratodentata atlantica, S. bipunctata* and *S. minima* breed in autumn and spring; mature individuals were found in both seasons. For the former two species the same was found in Eastern Mediterranean neritic waters (KEHAYIAS *et al.*, 1992). The mesopelagic species *Krohnitta subtilis* and *S. hexaptera* breed in spring since mature individuals were found only in March–April, while for the remaining mesopelagic species *S. decipiens* and *S. lyra* mature specimens were not observed in our samples, possibly due to their deeper than 300m mode of distribution (KEHAYIAS *et al.*, 1994). Mature specimens were also not observed for the epipelagic *S. enflata* possibly due to its low abundance in our samples. Juvenile specimens (stage I) were observed in both seasons for all different species. This suggests that spawning may occur in autumn and spring while the sampling should be extended monthly since a year round spawning in subtropical waters of Eastern Mediterranean could be evident (ALVARINO, 1965; KEHAYIAS *et al.*, 1992). In general, the population of each species according to its stage structure showed a more mature phase of its reproductive cycle in spring rather than in autumn.

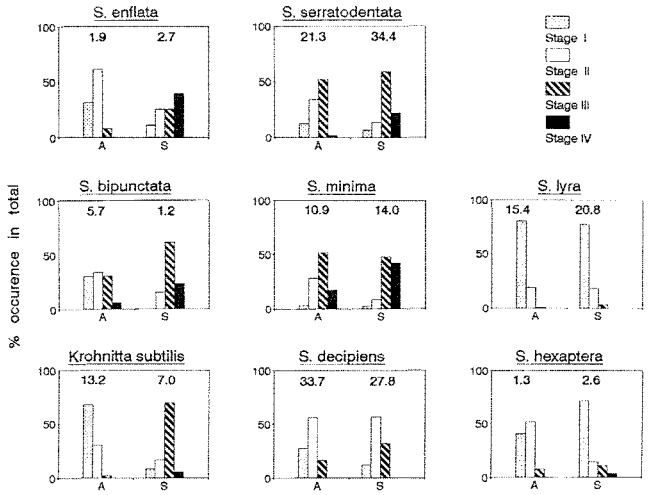


Fig. 2 Stage structure of eight chaetognath species (as % mean occurence of the different maturity stages of each species in Cretan Sea, Cretan Passage and Rhodes Sea) in autumn 1991 (A) and spring 1992 (S). Mean total abundance values (n/100m^3) are given for each species in each sampling period.

REFERENCES

ALVARINO, A., 1965. *Oceanogr. Mar. Biol. Ann. Rev.*, 3 : 115–194.

GHIRARDELLI, E., 1961. *Rapp. Comm. int. mer Medit.*, 24 (10) : 137–138.

KEHAYIAS, G., J. LYKAKIS and N. FRAGOPOULU, 1992. *Rapp. Comm. int. Mer Medit.*, 33 : 254.

KEHAYIAS, G., J. LYKAKIS and N. FRAGOPOULU, 1993. In: V. Papatha–nassiou and E. Charou (eds.), 4th Hellenic Symp. of Oceanogr. and Fish., Rhodes 1993. N.C.M.R., Athens, 85–88.

KEHAYIAS, G., N. FRAGOPOULU, and J. LYKAKIS, 1994. *Marine Biology*, 119 (4) : 647–653.

ECOLOGICALLY SIGNIFICANT SYMBIOSES IN THE MICROPLANKTON OF OLIGOTROPHIC SEAS. CASE STUDIES : THE EASTERN MEDITERRANEAN, THE GULF OF AQABA, RED SEA

Baruch KIMOR

Technion Institute of Technology, Haifa, Israel

The microplankton of oligotrophic warmwater seas is characterized by a large number of consortia, consisting of representative species of its plant and animal components. They vary from purely ephemeral attachment of one species to another, generally for reasons of support to truly symbiotic relationships involving metabolic dependency between the partners. These associations have been reviewed in recent years by TAYLOR, 1982; KIMOR *et al.*, 1992; and GORDON *et al.*, 1994 and references therein. Such associations involving algal consortism as well as algae with protozoans, markedly ciliates, radiolarians and acantharians, constituting ecologically significant relationships, have been documented in longterm studies in the eastern Mediterranean and the Gulf of Aqaba (KIMOR *et al.*, 1992 and GORDON *et al.*, 1994).

The Eastern Mediterranean. A case of algal consortism, involving two autotrophs, is that of the symbiosis between species of centric diatoms belonging to the genera *Rhizosolenia*, *Hemiaulus* and *Chaetoceros* with the filamentous heterocyst-bearing cyanobacterium *Richelia intracellularis* as an endobiont, the latter capable of molecular nitrogen fixation (MAGUE *et al.*, 1974). It is assumed that in this association the fragile cyanophyte provides the host diatom cell with floatation ability, due to its gas vacuoles, as well as with nitrogenous and carbohydrate compounds, while at the same time being protected by the rigidity of the diatom cell walls.

In the eastern Mediterranean the consortium of *Rhizosolenia calcar avis*, a bloom-forming diatom, large proportion of its cells containing at times filaments of *R. intracellularis*, has been found to occur mostly at the end the spring diatom increase (SDI), when the surface waters are particularly depleted of essential nutrients. Our past records (KIMOR, unpubl.) show the occurrence of this association in both neritic and open-sea waters of the Levant Basin, the latter described as highly oligotrophic (BERMAN *et al.*, 1984).

A well-known symbiotic association, consisting of the colonial radiolarian *Sphaerozoum punctatum* bearing photosynthetic zooxanthellae in the extra-cellular region of its individual cells, has been recorded in plankton samples examined live on board ship during a cruise in the eastern Mediterranean in April 1992. At that time, the colonies occurred as dense macroscopic masses over the whole grid of stations occupied by that particular cruise in the surface waters, both in neritic and oceanic waters. Although not quantified during the routine examinaton of the samples on board ship, *S. punctatum* may be assumed to have made a significant contribution to the primary productivity in that region, as has been described in the case of a taxonomically related species, *Collozoum longiforme*, from the equatorial Atlantic Ocean, with assimilation rates of one order of magnitude higher than phytoplankton - 43.2mgC/h as compared to 4-17mgC/h (SWANBERG and HARRISON, 1980). Considering the fact that the integrity of the colonies is affected by fixation in formaldehyde, the observation of live plankton on board ship in our samples was particularly important.

The Gulf of Aqaba, Red Sea. Long-term monitoring of the microplankton communities at a reference station in the northern part of the Gulf of Aqaba, Red Sea has been carried out since 1986 (KIMOR *et al.*, 1992; GORDON *et al.*, 1994) under the auspices of the National Center of Mariculture, Israel Oceanographic and Limnological Research Ltd. Among the various types of consortism described in this study, that of heterotrophic dinoflagellates with symbiotic coccoid cyanobacteria of the *Synechococcus/Synechocystis* type, similarly known for their molecular nitrogen fixation ability (MITSUI *et al.*, 1986), is of particular significance. Species belonging to the genera *Ornithocercus*, *Citharistes* and *Histioneis/Parahistioneis* harbouring clusters of the symbiotic cyanobacteria in special pouches either between the cingular lists or within the cells themselves have been recorded perennially during the months of October/November, when the nitrate concentration of the Gulf waters was at an all-time seasonal low (GORDON *et al.*, 1994). It is hypothesised that, in this particular case of algal consortism, the cynobacteria increase in concentration during the N-limitation months due to their nitrogen fixation capability, which is activated by the heterotrophic dinoflagellate hosts providing a site of low-oxygen tension. This hypothesis has yet to be proved experimentally.

The above examples of symbiotic consortism among various components of the microplankton in highly oligotrophic warm-water seas, such as those described in this study, may provide a clue to the nature and functioning of food chains in such particular marine environments.

REFERENCES

AZOV Y.,1986. Seasonal patterns of phytoplankton productivity and abundance in nearshore oligotrophic waters of the Levant Basin (Mediterranean). *J. of Plankton Res.*, Vol 8, 1 : 41-53.

BERMAN T., TOWNSEND D.W., EL SAYED S.Z., TREES C.C., AZOV Y., 1984. Optical transparency,chlorophyll and primary productivity in the Eastern Mediterranean near the Israeli coast. *Oceanol. Acta*, Vol. 7, .3 : 367-372.

GORDON N., ANGEL D.L., NEORI A., KRESS N., KIMOR B., 1994. Heterotrophic dinoflagellates with symbiotic cyanobacteria and nitrogen limitation in the Gulf of Aqaba. *Mar. Ecol. Prog. Ser.*, 107 : 83-88.

KIMOR B., GORDON N. and NEORI A., 1992. Symbiotic associations among the microplankton in oligotrophic marine environments,with special reference to the Gulf of Aqaba, Red Sea. *J. of Plankton Res.*, Vol. 14, .9 : 1217-1231.

MAGUE T.M., WEARE N.M. and HOLMHANSEN O., 1974. Nitrogen fixation in the North Pacific Ocean. *Mar. Biol.* 24 : 109-119.

MITSUI A., KUMAZAWA A., TAKAHASHI A., IKEMOTO H., CAO S., ANAI T., 1986. Strategy by which nitrogenfixing unicellular cyanobacteria grow photoautotrophically. *Nature*, 323 : 720-722.

TAYLOR F.J.R., 1982. Symbiosis in marine microplankton. *Annal. Inst. Océanogr.*, Paris, 58 : 61-90.

STATE OF ZOOPLANKTON IN THE BULGARIAN AND ROMANIAN BLACK SEA COASTAL WATERS DURING THE SUMMER OF 1992

A. KONSOULOV

Marine Biology and Ecology Depart., Institute of Oceanology, 9000 Varna, Bulgaria

Surveys of the composition, quantity development and distribution of zooplankton in the Black Sea are important for ascertaining trophic stability, as well as for clarifying the process mechanisms and phenomena related to translocation, transformation and sedimentation of organic matter, inflowing acutely polluting agents and the resulting high rate of eutrophication (KONSOULOV, 1986)

The results herewith, regarding the state of zooplankton within the above mentioned areas, have been obtained from a number of research expeditions within the programme Coms-Black 92/07/07-17/07/92 in particular. Zooplankton samples were collected on board R/V "Akademik" by means of Jeddy plankton net (mesh size 100 microns) at stations located in front of the Bulgarian and Romanian coast vertically off the 10-0, 25-10, 50-25, 100-50 and 150-200 metre horizons (Fig. 1). Monospecific biomass is calculated according to standard weights (IASHNOV, 1984). Highest quantitative abundance and biomass with quasi-homogeneous water structure in front of the Bulgarian and Romanian coasts during the summer of 1992 (July) were those of *Pleopis polyphemoides*, *Acartia clausi* and *Noctiluca scintillans*. Quantitative abundance of these three species varies both vertically and horizontally. The *P. polyphemoides* biomass amounted to 62.24 mg/m^3 in front of the Romanian coast, whereas it was 26.41 mg/m^3 in front of the Bulgarian coast. Results were similar with *N. scintillans* showing 428.36 mg/m^3 in Romanian coastal waters compared to 138.49 mg/m^3 in Bulgarian coastal waters. Quantitative abundance of *A. clausi* compared to that of the *Cladocera* species showed opposite results with 36.49 mg/m^3 of biomass at a 20 metre depth in front of the Bulgarian coast and 13.26 mg/m^3 at the estuary of the Danube, in front of Konstantza.

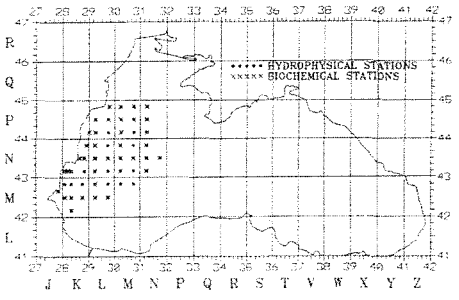
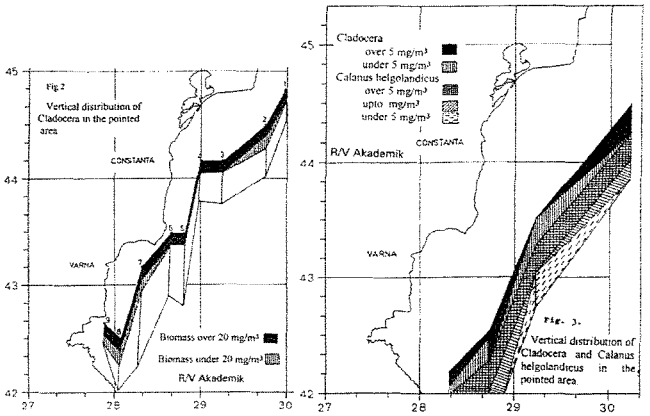


Fig. 1 : Academik station network

Vertically, surface strata ranging from 10 to 15 metre are chiefly inhabited by the *Cladocera* species (Fig. 2). Deeper down as far as the 20-25th metric isobath and 20-40 miles offshore, both biomass areas are dominated by *Pseudocalanus elongatus* and *Calanus helgolandicus* together with their copepodites and nauplii (Fig. 3). Together with the constantly living unicellular euriphague *N. scintillans* in the surveyed areas, there have been records the new invader in the Black Sea the *Ctenophora Mnemiopsis leidyi*, amounting to 68 ind/m^3 and sizing 20 mm along the Romanian coast, and 26 ind/m^3 in the shallow shelf of Bulgaria. More detailed analyses of data related to the composition of zooplankton and its quantitative development along the western parts of the Black Sea, as well as comparisons with previous years, show that during the summer 1992 the species *Oithona minuta* and *Oithona similis* were registered singularly, whereas over the 1984-1989 period mean values were 1928 and 424 ind/m^3 respectivelyThere is a similar trend of decrease with *Sagitta setosa*, *Paracalanus parvus*, *Centropages kroyery* and *Penilia avirostris*. Thus the average number of these species for the middle and western parts of the basin over the 1984-1989 period is respectively 29 ind/m^3, 178 ind/m^3, 96 ind/m^3 and 487 ind/m^3 dropping down to 4, 18, 31 and 63 ind/m^3 just in the summer 1992.

The surveyed process of destruction of pelagic zoocenoses during the ComsBlack'92 expedition can be explained with the high rate of eutrophication in the coastal zone. It is our opinion that the negative changes taking place within pelagic zoocenoses are not a result of the direct impact of eutrophication but a result of the favourable conditions created for the development of the predatory *Ctenophora - M. leidyi*. This species (together with *N. scintillans*) while developing and permanently spawning (KONSOULOV, 1990) consumes enormous quantities of juvenile and mature forms of lower *Crustacea* mainly at surface strata of coastal areas. Therefore if biodiversity is to be preserved, *M. leidyi* has to be most seriously considered as a part of the Black Sea ecosystem which by the rights of its existence undoubtedly influences ecosystemic composition and structure.



REFERENCES

IASHNOV, V.A., 1984. Instr. Vacsoiuzn. Nauchn. Izsl. Inst. Ocean., Moskow.

KONSOULOV, A., 1986. *Oceanology*, 17 : 19 - 23.

KONSOULOV, A., 1990. *Oceanology*, 19 : 98 - 101.

P

CYCLE ANNUEL DU PLANCTON CÔTIER DU LIBAN. SUCCESSIONS ET VARIATIONS SAISONNIÈRES DES PEUPLEMENTS

Sami LAKKIS

Centre de Recherches Marines, CNRS et Univ. Libanaise, B. P. 123, Jounieh, Liban

La situation géographique du bassin levantin entre la mer Rouge et la Méditerranée occidentale et l'influence du canal de Suez sur le bassin oriental de la Méditerranée attribuent au plancton des eaux libanaises des caractéristiques biogéographiques subtropicales (LAKKIS, 1980). La salinité, parmi les plus élevées de toute la Méditerranée, la température moyenne forte et l'oligotrophie des eaux levantines sont autant de facteurs qui affectent le cycle annuel du plancton. Dans cette étude, nous allons définir le cycle annuel par la succession écologique des peuplements. Les résultats sont basés sur 25 années d'observation accompagnée de mesures hydrologiques : T°, S‰°, chlorophylle, transparence, sels nutritifs (LAKKIS, 1990). Le phytoplancton et le microzooplancton ont été récoltés au filet 50 µ , le picoplancton et le nanoplancton n'étant pas pris en considération; les filets 200 et 500 µ ont été utilisés pour la pêche du zooplancton en traits de surface et verticaux (0-50 m). Le plancton des eaux libanaises est caractérisé par une grande diversité spécifique, des variations saisonnières importantes et une pauvreté relative de la biomasse. La communauté planctonique comprend presque tous les groupes du phyto- et du zooplancton suivant les proportions :

Groupes	Abondance relative	N. d'espèces
Phytoplancton		
Diatomées	60% du microphytoplancton	120
Dinoflagellés	30% ..."	157
Silicoflag., Coccolith., etc.	10% ..."	15
Microzooplancton		
Tintinnides	90% ..."	102
Foram., Acanth., Radiol., etc.	10% ..."	28
Macrozooplancton		
Copépodes	65% de la biomasse du zooplancton	173
Larves de crustacés	7% ..."	145
Appendiculaires	5% ..."	15
Cladocéres	4% ..."	6
Chaetognathes	4% ..."	10
Larves planctoniques	4% ..."	20
Hydroméduses + Scyphom.	3% ..."	72
Siphonophores	3% ..."	25
Œufs et larves de Poissons	2% ..."	85
Gym., Théc., Hét., Ptér.	2% ..."	15
Amphip., Ostrac., Cumacés	1% ..."	35

Le cycle annuel des peuplements planctoniques peut être défini par une succession annuelle principale formée par 3 stades écologiques, et l'ébauche d'une succession secondaire. Le profil des variations saisonnières est le même d'une année à l'autre avec de légères modifications spatio-temporelles (Fig.1). Ces stades schématisés à la Fig.2 comprennent une succession principale : le stade 1 correspond à la période hivernale (décembre, janvier, février). Cette phase d'homothermie est marquée par un brassage des masses d'eau, une homogénéisation des couches sub-superficielles. La température minimale de 16°C est enregistrée en février alors que les valeurs de la salinité sont modérées (S = 38,50-39‰°) suite aux apports en eau douce (LAKKIS et ZEIDANE, 1983). Certaines espèces hivernales de diatomées dominent le phytoplancton, mais le zooplancton carnivore caractérise la communauté : *Sagitta friderici, S. enflata, Oithona spp., Farranula rostrata, Oncaea spp., Candacia spp., Euchaeta marina, Pleuromamma sp. Liriope* et *Rhopalonema* ainsi que des larves planctoniques diverses .

Fig.1-Variations saisonnières comparées Phyto-Zoo.

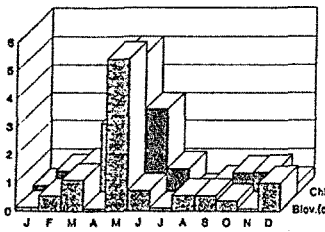
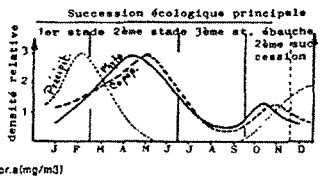


Fig.2-Schéma des successions



Le stade 2 correspond à la période printanière (mars, avril, mai). Avec le début du réchauffement en avril (20-24°C) et suite à l'enrichissement en sels nutritifs, le phytoplancton manifeste une poussée printanière due à plusieurs espèces de diatomées (*Skeletonema, Chaetoceros, Rhizosolenia, Nitzschia, Thalassionema, Bacteriastrum*), et à quelques dinoflagellés *(Ceratium, Protoperidinium et Dinophysis)*. Il en résulte un développement de zooplancton en majorité filtreur de petite taille (copépodes, appendiculaires, thaliacés, larves planctoniques). On note parallèlement un développement important des larves de décapodes (LAKKIS et ZEIDANE, 1988). Le stade 3 coïncide avec la période estivale chaude (juin-octobre). La température de surface monte à 30°C et la thermocline s'installe entre 35 et 75 m. Les dinoflagellés commencent à se développer *(Ceratium* et *Protoperidinium)* au détriment des diatomées qui diminuent en densité et en espèces. Le zooplancton côtier est dominé par les cladocéres, les larves d'anomoures, de brachyures, de lamellibranches, de prosobranches et des œufs de poissons apodes. Des espèces indo-pacifiques apparaissent en juillet et demeurent jusqu'en décembre. Le plancton s'appauvrit suite à la stratification et l'épuisement des sels minéraux par le phytoplancton printanier.

L'ébauche d'une seconde succession écologique, de courte durée, se manifeste entre mi-octobre et mi-décembre avec une légère poussée du phytoplancton suite à la reminéralisation de la matière organique. Le zooplancton est caractérisé par des espèces carnivores et le plancton montre une grande richesse spécifique.

REFERENCES

LAKKIS S., 1980. - Journées Etud. System. et Biogéogr. Médit., Cagliari, CIESM, 59-63.
LAKKIS S.,1 990. - *Bull. Inst. Océanogr.* n° Special, 7 : 79-89.
LAKKIS S., 1994. - *Lebanese Science Bulletin*, 7, 1 : 69-93.
LAKKIS S. et ZEIDANE R., 1983. - *Rapp. Comm. int. Mer Médit.*, 28, 9 : 215-216.
LAKKIS S. et ZEIDANE R., 1988. - *Lebanese Science Bulletin*, 4, 2: 5-33.

LE GENRE *DINOPHYSIS* EHRENBERG DES EAUX CÔTIÈRES LIBANAISES. COMPOSITION ET DISTRIBUTION SPATIO-TEMPORELLE DES ESPÈCES

S.LAKKIS et R.ZEIDANE

Centre de Recherches Marines, CNRSL & Univ. Libanaise, B.P.123, Jounieh, Liban

L'intérêt de cette étude tient à deux raisons : sur le plan taxonomique, le genre *Dinophysis* suscite quelques confusions dans la détermination des espèces voisines, alors que sur le plan toxicologique, certaines espèces sont connues comme étant des formes toxiques (LASSUS, 1988). Des travaux antérieurs ont révélé la présence de huit espèces de *Dinophysis* dans les eaux libanaises (LAKKIS & NOVEL-LAKKIS, 1981). Le genre est également représenté dans les deux bassins méditerranéens. TRAVERS (1975) signale à Marseille 34 espèces, dont 23 communes avec le bassin levantin. HALIM (1969) mentionne 14 espèces en mer Rouge, dont 11 communes avec les eaux libanaises. TAYLOR (1976) cite 22 espèces dans l'océan Indien dont 14 sont présentes dans nos eaux. DOWIDAR (1976) signale 15 espèces dans le canal de Suez dont 10 sont recensées sur la côte levantine. Sur les 71 espèces de *Dinophysis* signalées par BALECH (1988) dans l'Atlantique sud-occidental, 21 sont présentes dans le bassin levantin montrant ainsi l'affinité subtropicale de la plupart des espèces.

Des pêches planctoniques de surface et des traits verticaux (0-50 m) ont été effectuées à l'aide de filets 50 µ dans 6 stations couvrant des zones côtières, portuaires, polluées et au large; 300 échantillons ont été récoltés entre 1983 et 1993. 28 espèces dont 14 de détermination incertaine ont été identifiées (Tableau 1). La majorité des espèces sont pérennantes; *Dinophysis caudata* est la plus abondante, contribuant à la poussée printanière du phytoplancton, abondante dans la colonne 0-50 m ainsi que dans les eaux côtières et portuaires, rare dans les stations polluées (LAKKIS, 1991). Le pic annuel se situe entre avril et juin (moyenne 2000 cell./l-1). Les espèces ayant une faible densité sont : *D. doryphora, D. parvula, D. rapa, D. amandula, D. mitra.* D'autres espèces sont sporadiques : *D. schroederi, D. tripos, D. odiosa, D. cuneus* et *D. infundibulus.* Les stations néritiques et celles du large sont également riches tant en nombre d'espèces qu'en densité, à l'exception des zones polluées beaucoup plus pauvres. La distribution spatiale des espèces montre les observations suivantes :

- espèces côtières : *D. rapa, D. parvula, D. doryphora, D. amandula, D. porodictyum,*
- espèce commune dans la couche 0-30 m. : *D. mitra,*
- espèces fréquentes dans la couche 0-50 m : *D. schüetti, amandula, parvula, doryphora,*
- espèces fréquentes dans l'eau dessalée : *D. mitra, D.porodictyum, D.rapa, D. amandula,*
- espèces océaniques : *D. doryphora, D. mitra, D. rapa, D. amandula,*
- espèces fréquentes dans les eaux portuaires : *D. doryphora, D. parvula, D. recurva.*

La distribution saisonnière définie par l'analyse de la classification hiérarchique basée sur les coefficients de similitude délimite cinq groupements d'espèces

- espèces pérennes : *D. amandula, D. doryphora, D. parvula , D. porodictyum,*
- espèces hivernales : *D. infundibulus, D. schüetti, D. cuneus, D. rapa,*
- espèces printanières: D. *amandula, doryphora, fortii, hastata, parvula, porodictyum, rapa,*
- espèces estivales : *D. amandula, D. argus, D. doryphora, D. mitra,*
- espèces automnales : *D. doryphora, D. parvula, D. schüetti.*

Les mois de mai et novembre sont les plus riches en nombre d'espèces (12 et 9), les plus pauvres étant mars, juillet et août. L'analyse de la diversité spécifique temporelle montre des indices élevés en août (H' = 1.641bits/ind.) et en novembre (H'=1,615), l'indice le plus faible étant en juillet (0,191). La diversité hiérarchique spatiale montre une diversité faible aux stations polluées et portuaires (H' = 0.174) et plus élevée aux stations côtières et dans la couche 0-30m. Mise à part *D.caudata*, les espèces toxiques sont présentes en densité très faible ne dépassant pas 500 cellules/l-1 : *D. fortii, D. acuminata, D. acuta.* Aucun cas d'intoxication n'a été déclaré, encore que la consommation de bivalves crus n'est pas de tradition au Liban. Sur les 29 espèces rencontrées, 18 seraient des espèces migratrices lessepsiennes ou d'origine indo-pacifique.

Espèces	J	F	M	A	M	J	J	A	S	O	N	D
Dinophysis amandula Sournia	11	1	0	1	0	0	3	1	0	2	0	0
* *D.caudata* Saville-.	5	25	15	30	90	60	20	10	0	5	0	5
* *D.cuneus* (Schütt)Abé	0	1	0	0	0	0	0	0	0	0	0	0
* *D.doryphora* (Stein) Abé	1	1	1	1	0	0	0	1	1	10	1	0
* *D.hastata* Stein	0	0	0	1	0	0	0	0	0	0	0	0
* *D.infundibulus* Schiller	1	1	0	1	0	0	0	0	0	0	0	0
* *D.mitra* (Schütt) Abé	0	0	0	0	0	0	0	5	0	0	1	0
* *D.parvula* (Schütt) Balech	0	1	2	3	1	2	1	1	0	0	7	0
* *D.porodictyum* (Stein) Abé	0	0	0	1	1	0	0	1	0	1	0	1
D.odiosa (Pavill.)Tai a. Skogsb	0	0	0	0	1	0	0	0	0	0	0	0
* *D. rapa* (Stein) Abé	0	1	2	6	1	7	0	0	0	0	0	0
* *D.schroederi* Pavillard	0	0	1	0	0	0	0	0	0	0	0	0
* *D.schüetti* Murr. & Whitt.	0	1	0	0	0	0	0	0	0	0	2	1
* *D.tripos* Gourret	0	0	0	0	0	1	0	0	0	0	0	1
Espèces incertae sedis												
Dinophysis acuminata Clap. & Lachm.	0	0	0	0	0	1	0	0	0	0	0	0
D.acuta Ehrenberg	0	0	0	0	0	0	0	0	0	1	0	0
* *D.acutoides* Balech	0	0	0	0	0	0	0	1	0	0	0	0
* *D.argus* (Stein) Abé	0	0	0	0	0	0	0	1	0	0	0	0
* *D.circumsuta* (Karsten) Balech	0	0	0	0	0	0	0	0	0	0	1	0
D.fortii Pavillard	0	0	0	0	0	0	0	0	1	0	0	0
D. hindmarchi (Schütt) Abé	0	0	0	0	0	0	0	0	0	0	0	1
* *D.operculata* (Stein) Balech	0	0	0	0	0	1	0	0	0	0	0	0
D.ovum Schütt	0	0	0	0	1	0	0	0	0	0	0	0
D.recurva Kof. & Skogsb.	0	0	0	2	3	1	0	0	1	0	0	0
D.rotundatum Clap.& Lachm.	0	0	0	0	1	0	0	0	0	0	0	0
* *D.similis* Kof.a. Skogsb.	0	0	0	0	1	0	0	0	0	0	0	0
* *D.sphaerica* Stein	0	0	0	0	0	2	0	0	0	0	0	0
D.umbosa Shiller	0	0	0	0	0	0	0	0	0	0	1	0

Tableau 1- Liste taxonomique et distribution des espèces de *Dinophysis* rencontrées dans les eaux libanaises entre 1983-1993. Le % de fréquence est donné .
* = Espèce d'origine indo-pacifique ou éryhtréenne au Liban.

REFERENCES

BALECH E., 1988.- *Publs. espec. Inst. Esp. oceanogr.*, 1 : 1-310, pl.1-38.
DOWIDAR M.N., 1976.- *Acta Adriatica*, XVIII,1/23 : 239-275.
HALIM Y., 1969.- *Oceanogr. Mar. Biol. Ann. Rev.*,7 : 231-275.
LAKKIS S., 1991.- *Rev. Int. Océanogr Médic.*,101/104 : 115-123
LAKKIS S. and LAKKIS-NOVEL,V., 1981.- *Journal of Plankton Research*, 3,1 : 123-136
LASSUS P., 1988.- Publication s IFREMER/Nantes, 111 p.
RAMPI L.E. BERNHARD M., 1980.- Comitato Nazional Energia Nucleare, Roma, 190 p.
SCHILLER J., 1931-37.- *Akademische Verlag*, Leipzig, Teil 1 : 1-617 (1931), Teil2 : 1-590 (1935-37)
TRAVERS M., 1975.-*Ann. Inst. Océanogr.*, Paris, 51(1) : 51-75.
TAYLOR F.J.R., 1976.- *Bibliotheca botanica*, 132 : 1-234, pl. 1-46.

SEASONAL TRENDS IN THE VERTICAL DISTRIBUTION OF COPEPODS IN THE BAY OF MALI STON (SOUTHERN ADRIATIC)

Davor LUCIC

Biological Institute, HRV - 50001 Dubrovnik, Croatia

Eleven daytime plankton samples were taken from March 1989 through July 1990 at Usko Station (N 42°40', E 18°05', 14-m depth) in the Bay of Mali Ston (Croatia). Samples were spaced at 2-m intervals with 125 µ mesh using a new type of zooplankton sampler (volume 250 l) described by KRSINIC (1990). The sampler can be efficiently used in quantitative investigations and vertical distribution of mesozooplankton in shallow waters (KRSINIC and LUCIC, 1993). The main objective of this paper is to describe potential of precise studies of copepods vertical distribution in the Bay of Mali Ston, a natural shellfish region. With regard to these first annual investigations on vertical distribution of copepods with this new tool, there are not comparisons with the other shallow regions in the Mediterranean Sea.

Of 40 copepod species identified, the calanoids *Paracalanus parvus, Centropages kroyeri* and *Acartia clausi* dominated. Among cyclopoids, *Oithona nana* was exceptionally dominant, followed by species of the *Genus Oncaea. Oithona helgolandica* and *Euterpina acutifrons* also were abundant.

Densities of copepods and copepodites were very high (Fig. 1). In spring, concentration increased toward the bottom; in April, 1989, density was 102,700 ind.m^{-3}. In August, the vertical distribution of copepod abundance was low near the surface (ca. 10,000 ind.m^{-3}), maximum at 8 m (56,000 ind.m^{-3}) and intermediate at other depths (ca. 20,000 ind.m^{-3}). With the exception of bottom layers, total abundance decreased during autumn. During winter, abundance again increased and, in February, a season maximum of 146,300 ind.m^{-3} was recorded. An exceptionally high concentration of 120,300 m^{-3} was also found in July 1990, at 12 m.

Differences in the vertical distribution of population density were significant (ANOVA, F=9.205. P<0.001). Surface (0 and 2 m) and mid-depth (4 and 6 m) concentrations were similar; in turn, these were different from concentrations found in deeper samples (Tab. 1).

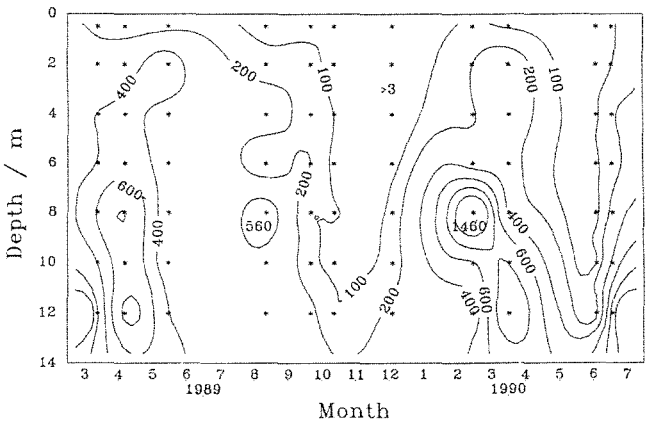


Fig.1. Distribution of copepods and copepodites (100 ind.m^{-3}) during 1989-1990 at Usko Station, Adriatic Sea.

LAYERS	bottom - medium	MIN - MAX	X ± S.D.
surface	P<0.001 N.S.	99 - 16587	5633 ± 5133
medium	P<0.001	279 - 54270	21238 ± 14330
bottom		3195 - 146300	41362 ± 36829

Tab.1. Comparison of the total abundance of copepods and copepodites between surface (0 and 2 m), middle (4 and 6) and bottom layers (8, 10 and 12 m) at the Usko station in the Bay of Mali Ston during 1989/90

(SNK-test,'=significant differences at 95%, N.S.=not significant).

REFERENCES

KRSINIC F.,1990. A new type of zooplankton sampler. *Journal of Plankton Research*, 12 : 337-343.

KRSINIC F. and D. LUCIC,1994. Mesozooplankton Sampling Experiments with the "Adriatic" Sampler: Differences of Catch Between 250 and 125 mm Mesh Netting Gauze. *Estuarine, Coastal and Shelf Science*, 38 : 113-118.

PHYTOPLANKTON IN THE ORGANIC PARTICULATE MATTER FLUX IN VARNA BAY (BLACK SEA)

S. MONCHEVA[1], V. DONCHEVA[1], G. STEREVA[1], A. KONSOULOV[1], E. KOZHUHAROV[2]

[1] Institute of Oceanology, BAS, Varna, Bulgaria
[2] Institute of Geology, BAS, Sofia, Bulgaria

Varna Bay is one of the most affected by the anthropogenic pressure regions along the Bulgarian Black sea coast. Dramatic changes both in the chemistry and in the biology have been reported. An apparent shift in the dominant phytoplankton species composition together with an increase in the frequency and duration of the blooms have been well documented, the anoxia conditions during summer period becoming a recurrent phenomenon (MONCHEVA *et al.*, 1993). As the autochthonous organic matter produced as a consequence of eutrophication has been considered the key factor in the ecological disaster of the area, the investigation of the nature and fate of the organic flux constitutes a major interest. The subject of the present paper is to highlight the role of phytoplankton component in the organic matter and the dominant mechanism of its downflux transition in respect to the variability of some chemical and biological characteristics. The results are based on sampling from May to November 1993. The following determinants have been measured : temperature, O_2, pH, NH_4, Pmin., Porg, Ptot., Corg. and Ptot. in the suspended matter, zooplankton and phytoplankton species composition and abundance, Chl. A in the water. The flux of some of these parameters have been measured in sediment traps deployed, including fecal pellets, separated in geometrical and size classes. The phytoplankton standing crop is characterized by both high abundance and biomass during the entire period ranging from 1.3 to 12x10^6 cells/l and from 11.2 to 35.4 mg/l Chl A. The highest value is reached at the end of July (443) and the lowest at the end of May (0.1). It is the only case of *Chrysophyta* and *Dinophyta* species overdominating the BC species (Fig.1, 2). A sequence of blooms have been registered with the following principal species involved : *Chaetoceros socialis Laud., Cerataulina bergonii Perag., Peridinium triquetrum (Ehr.) Lebour., Prorocentrum minimum Ost., Emiliana huxleyi (Lohm.) Kampt* (May-June); *C. bergonii, Ch. socialis, Nitzschia closterium Cl., Detonula confervaceae (Cl.) Gran.* (July); *Skeletonema costatum (Grev.) Cl., C. bergonii* (September) and *Leptocylindrus minimus Gran., Thalassiosira subsalina Pr. Lavr., Th.parva Pr. Lavr.* (November). The summer phytoplankton assemblage registered is not typical for this season when usually dinoflagellates predominate. Most likely this could be related to the specific hydrological conditions. The dominance of western winds prevents the persistence of water stratification and supports nutrients input facilitating the maintenance of high diatom standing crop (SMETACEK, 1991) and high phytoplankton biomass (fig.1). The latter suggestion is supported by the graphs plotted on Fig.2. The comparison of zooplankton fecal pellets flux (Fp) with the NH_4 concentrations suggests a considerable contribution of Fp to NH_4 possibly related to their high disintegration rate (SMETACEK, 1980). Chl A, Corg. and Chl A : ZB curves provide indication of two patterns of interrelations. In the first one (31.05-22.06, the termination of spring bloom) the Chl. A-Corg lines are inverse probably due to the increased zooplankton crop (low Chl. A : ZB ratio) at almost equal Chl. A concentrations and Chl. A:Corg ratio (34.6%-21%). The ratio BC : NBC is low. In the second one Chl. A curve is almost parallel to Corg variability. The share of Chl. A in Corg. varies from 55% to 77.8% with the exception of August (26%; the termination of second bloom). The ratio of BC:NBC is high (Fig. 2B). The organic matter flux determinants considered (Fig. 2C) manifest both a direct settling of phytoplankton cells and zooplankton fecal pellets as possible mechanisms of sedimenting out the excess of phytoplankton biomass. The suspected switching factor is the BC : NBC ratio and the species composition. This is supported by the comparison of the dominant species record in the water and the sediment trap. The BC : NBC ratio in the sediment traps differs considerably from that from the watershed (0.09-34.2). The Fp seem to account for the phytoplankton transfer to sediments at a high BC:NBC water ratio (exceeding 100 in our case study). The variability of Chl. A in the sediment flux follows that in the water column with a time lag, the higher the phytoplankton biomass the greater the proportion that sediments out (Fig. 2D). The same stands for the Corg flux. The data presented suggest the following conclusions preliminary. Phytoplankton in Varna Bay is maintained high despite the magnitude of variation typical for eutrophicated areas. The same stands for Chl. A proportion and Corg in the water domain (ranging from 27 to 77%). The possible factor controlling the ratio Corg : Chl. A could be zooplankton grazing. Phytoplankton may be considered as a major component in downflux. The species composition and BC : NBC ratio in the water column seem to be decisive in the sedimentation mode, Fp dominating the flux at high BC:NBC ratio.

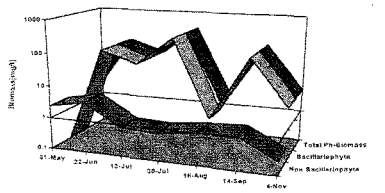


Fig.1. Phytoplankton biomass dynamics in log scale.

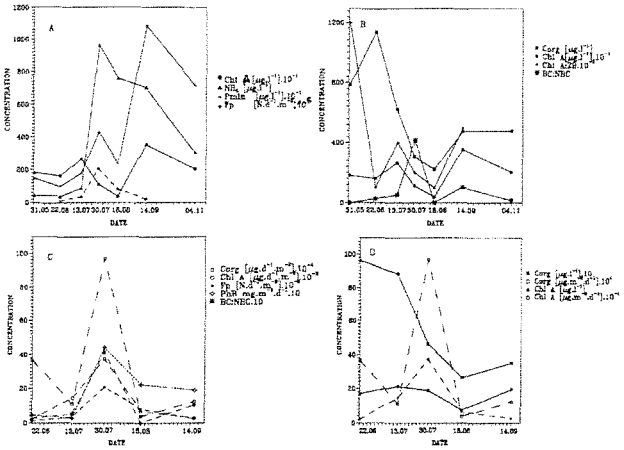


Fig. 2 : Dynamics of the main determinants in the water column (solid line) and in the sediment traps (dashed line) ZB- zooplankton biomass; Ph B-phytoplankton biomass; BC:NBC (Bacillariophyta:Non Bacillariophyta biomass)

P

SEASONAL DYNAMICS OF DINOPHYSIS SPP. WHICH CAUSED A DSP OUTBREAK DURING THERMAL STRATIFICATION IN THE GULF OF TRIESTE

Patricija MOZETIC[1] and Robert OBAL[2]

[1] Marine Biology Station, Piran, National Institute of Biology, Ljubljana, Slovenia
[2] Veterinary Institute of Primorska, Sezana, Department of Koper, Slovenia

Many recent reports of algal blooms recorded in several inshore waters, including harmful effects provoked by toxic species, suggest that such toxic blooms are becoming more frequent and more wide spread (SMAYDA, 1990).

The outbreak of diarrhetic shellfish poisoning (DSP) in the Gulf of Trieste (Adriatic Sea) was recorded for the first time in September 1989 (SEDMAK & FANUKO, 1991) and was associated with an increased cell density of eight *Dinophysis* species. The highest abundance of *Dinophysis* spp. in September 1989 coincided with the toxicity peak in mussels from two shellfish farms in inshore waters along the Slovenian coast. DSP toxins were again detected in mussels during routine monitoring (mouse assay, YASUMOTO, 1981). High temperatures, a stratified water column and the relative absence of turbulence are conditions known to be favourable for growth and persistence of relative high abundances of dinoflagellates from late spring to early autumn (PAERL, 1988; DELMAS *et al.*, 1992).

In view of these findings and our own data from 1986-1992 revealing the presence of *Dinophysis* spp. from May to October, we followed *Dinophysis* spp. abundance as well as environmental conditions (temperature, salinity, water column stratification), including nutrients during 1993. Sampling was carried out at five depths (subsurface, 5, 10, 15 m and above bottom) in an offshore station in the southern part of the Gulf of Trieste (depth of 20 m) in the vicinity of two shellfish *Mytilus galloprovincialis* farms from May to October 1993, monthly, and approximately biweekly from mid-June to mid-September 1993. From fixed sea water samples (1 l) for phytoplankton counts, subsamples of 100 ml were concentrated in the sedimentation chambers and the entire chamber bottom was examined at 100 x magnification according to UTERMÖHL (1958). Water samples for nutrients (PO_4^{3-}, NO_3^-, NO_2^-, NH_4^+, Si) were analysed using standard colorimetric procedures (GRASSHOFF, 1976). Hydrographic profiles were recorded using a CTD probe. During the investigated period the temperature ranged from 12.6°C (May) to 26°C (end of August). The most pronounced thermal stratification of the water column was observed at the beginning of June (ΔT = 7.85°C; ΔT = temperature between the base of the upper mixed layer and the bottom), while the whole summer period (July and August) was characterised by a thick (10 to 16 m) homogeneous upper layer and a slight decrease of surface temperature (from 26 to 23.2°C). The water column was well mixed in September and October. The pool of inorganic nitrogen ($NO_3^- + NO_2^- + NH_4^+$) was never completely exhausted and the concentrations were always above 1 µmol/l. During the period of thermal stratification the concentrations of phosphate above the thermocline remained low, while below the thermocline they increased. Silicate varied from very low values in July (0.63 µmol/l) to extremely high (11.95 µmol/l) in August after a thunderstorm.

Five *Dinophysis* species were found from May to October : *D. acuminata, D. caudata, D. fortii, D. rotundata* and *D. sacculus. D. caudata* and *D. fortii* were registered over the entire investigated period and *D. rotundata* occurred sporadically almost on every sampling. On the contrary, *D. sacculus* and *D. acuminata* were present in July and from August to September, respectively. Surprisingly, over the period of the most pronounced stratification the cell density of *Dinophysis* spp. was low (up to 40 cells/l below the thermocline). Only at the end of August, when the water column became homogenised, *Dinophysis* spp. cell numbers increased to reach the maximal density of 4460 cells/l, followed by a slight decrease to 1260 cells/l in September and 770 cells/l in October. Only a few specimens of *Dinophysis* spp. were present in water samples in November. In the period of the maximal density the highest concentrations occurred between 10 and 15 m, while above the bottom cell numbers were much lower. The only exception was the sampling on 26 August, when bottom density exceeded 4400 cells/l, and was approximately 50 times higher than densities from the upper water layers. In October *Dinophysis* spp. cells were equally distributed through the water column. No significant correlation was found between cell numbers and nutrient concentrations.

Mouse bioassays on mussels growing in two shellfish farms near the sampling station were carried out from the beginning of July to mid-November. The first positive result for the presence of DSP toxins was recorded at the end of August and lasted till the end of October. In November the mouse test was negative.

These results coincided well with the increased cell density of *Dinophysis* spp. at the end of the summer and the scarcity of toxic species in water samples in November. A distinctive feature was the long persistence of DSP found in wild growing shellfish (mainly *Arca noe*) from different locations in the vicinity of the sampling station. Toxicity was detectable until January 1994, although no *Dinophysis* species were found from December on. One reason is probably the low winter sea temperatures which reduce the metabolic activity of shellfish and thus slow down the detoxification processes (SECHET *et al.*, 1990), but we also have to consider the ecophysiological characteristics that differentiate *Arca noe* from the blue mussel.

P

REFERENCES

DELMAS D., A. HERBLAND and MAESTRINI S.Y., 1992. Environmental conditions which lead to increase cell density of the toxic dinoflagellates *Dinophysis* spp. in nutrient-rich and nutrient-poor waters of the French Atlantic coast. *Mar. Ecol. Prog. Ser.*, 89: 53-61.

GRASSHOFF K., 1976. Methods of seawater analysis. Verlag Chemie. Winheim. 317 pp.

PAERL H.W., 1988. Nuisance phytoplankton blooms in coastal, estuarine, and inland waters. *Limnol. Oceanogr.*, 33: 823-847.

SECHET V., P. SAFRAN, P. HOVGAARD and YASUMOTO T., 1990. Causative species of diarrhetic shellfish poisoning (DSP) in Norway. *Mar. Biol.*, 105: 269-274.

SEDMAK B. and FANUKO N., 1991. Occurrence of *Dinophysis* spp. and toxic shellfish in the Northern Adriatic. *J. appl. Phycol.*, 3: 289-294.

SMAYDA T.J., 1990. Novel and nuisance phytoplankton blooms in the sea: evidence for a global epidemic. In Granéli E., B. Sundström, L. Edler and Anderson D.M. eds., Toxic Marine Phytoplankton. Elsevier, New York. 29-40.

UTERMÖHL H., 1958. Zur Vervollkommung der quantitativen Phytoplankton-Methodik. *Mitt. int. Ver. theor. angew. Limnol.*, 9: 1-38.

YASUMOTO T., 1981. Method for the bioassay of diarrhetic shellfish toxin. *Shokuhin Eiseigaku Zasshi, 31*: 515-522.

SERGESTES ARCTICUS KRÖYER 1855: SIZE GRADIENTS IN THE LIGURO-PROVENÇAL BASIN

L. ORSI RELINI, C. CIMA, G. PALANDRI, M. RELINI, G. TORCHIA

Laboratori di Biologia Marina ed Ecologia Animale, Istituto di Zoologia, Università di Genova, Via Balbi 5, 16125 Genova, Italia

The study of samples of pelagic Eucarid crustaceans obtained from a large area in the Liguro-Provençal basin gives evidence to density and size gradients which are probably influenced by the surface circulation. A relationship between life cycles and drift in the water masses is suggested. 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, Genoa-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 an 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 17.55 m^2; the amount of filtered water per hour was 97571 m^3. After the sorting, crustacean decapods were identified as to species and measured as to carapace length in mm under the dissecting microscope. This paper concerns *Sergestes arcticus*, the second most abundant species among crustacean decapods, for which the vertical space covered by the sampling includes the largest part of the population (FRANQUEVILLE 1971, SARDOU and ETIENNE 1988). In this species ontogenetic migrations have been described. At night young specimens crowds surface waters (HARGREAVES 1984). Maturity in males is at about 28 mm tl (HANSEN 1922) which corresponds to 8 mm carapace l. Females reach larger sizes. A total of 1156 specimens was collected with numbers ranging from 8 to 189 per haul. The carapace length-frequency distributions can be assigned to three groups :

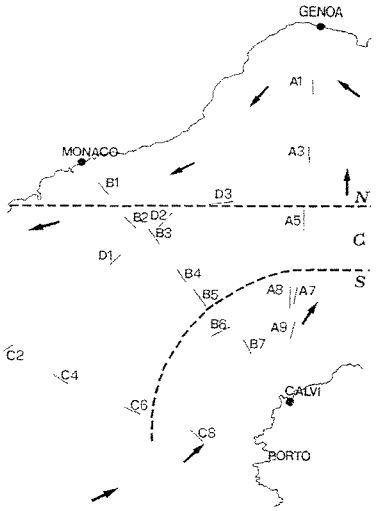


Fig.1. Sampling stations (capital letters and numbers) and surface currents (arrows) are indicated. On the basis of sizes of *Sergestes articus*, three sectors (N. northern, C. central, S. southern) have been distinguished.

- a) Northern sector of the Basin, i.e. Stations A1, A3, B1, D3; *S. arcticus* is present with low densities (average 41.76 per haul) and large sizes (Fig. 2a).
- b) Southern sector, on the Corsican side (St. A7, A8, A9, B6, B7, C8): the average number of shrimps is 54.34; a significant part of the length-frequency distribution is formed by small individuals (Fig. 2c).
- c) Central sector encircled by the Liguro-Provençal front (St. A5, B2, B3,B4, B5, D1, D2, C2, C4, C6) : samples are generally richer in number (N=66.3) and composed of both young (in lesser quantity) and adults (Fig. 2b).

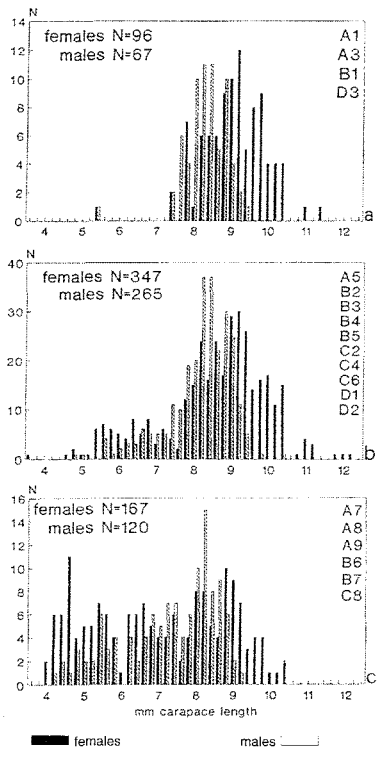


Fig. 2 a, b, c. Length/frequency distributions of *S. arcticus* recorded in the northern, central and southern sectors of the sampled area.

In our opinion the concentration of young individuals in the Corsican sector is of particular interest, indicating a nursery area which is probably fed from the South-West. In fact, it could be related to a drift along the Atlantic surface waters, a branch of which enters the Gulf of Genoa from the South along the West coast of Corsica. On the other hand, large individuals can move by means of the Liguro-Provençal coastal current towards the West, gaining a position from which eggs and larvae can return to the Corsican area. The overall drift of the shrimps is probably slower than the current gyre, given that *S. arcticus* moves daily up and down in the water column, touching water layers which have different speeds (the deepest layers are also the slowest). Young individuals could be transported more quickly because they inhabit higher waters than adults. We have recorded this general pattern of distribution of young and adults in other eurybathic crustacean decapods and euphausiids of the same area. Horizontal migrations necessary to complete the life cycle have been described in several species of Acetes (XIAO and GREENWOOD, 1993).

REFERENCES

FRANQUEVILLE C. 1971. *Téthys*, 3 (1) : 11-56

HANSEN H. J. 1922. *Res. Camp. Sci. Monaco* 64 : 1-232

HARGREAVES P.M. 1984. *J. Mar. Biol. Ass. U.K.* 64 : 829-857

SARDOU J. and ETIENNE M. 1988. *Rapp. Comm. int. Mer Médit.*, 31(2): 238

XIAO Y. & GREENWOOD J.G. 1993. *Oc. Mar. Biol. Ann. Rev.* 31 : 259-444.

INTERANNUAL DIFFERENCES IN PHYTOPLANKTON SEASONAL CYCLES IN SARONIKOS GULF

K. PAGOU

National Center for Marine Research, Aghios Kosmas, Hellinikon, Greece

The originally oligotrophic waters of the Saronikos Gulf have been locally submitted to eutrophication due to a continuous input of nutrient-rich sewage from urban and industrial origin. Hence the former seasonal phytoplankton cycle (IGNATIADES, 1969) has been affected. This study considers the effects of the effluents on both the algal abundance and distribution (chl. *a*) and on the annual cycle (FRILIGOS, 1985; PAGOU and IGNATIADES, 1988). Monthly samplings (April 1982 to March 1983 and April 1989 to March 1990) were done at 1 m depth (Niskin bottles) at two stations : S1 in an eutrophic environment (sewage from Athens) and S2 in an almost oligotrophic area. Different parameters were determined (see Table 1). A similarity matrix using the Bray-Curtis measure of similarity on log (x+1) data of the main phytoplankton groups abundance was subjected to MDS analysis (KLARKE and GREEN, 1988). Although temperature and salinity values did not differ between stations, the ranges and mean values of nutrients (Table 1) confirmed the eutrophic character of station S1 in relation to S2, for both sampling periods. The results from the chlorophyll *a* and phytoplankton cell data showed that the eutrophic environment promoted the growth of phytoplankton (Table 1) for both periods. However, differences on phytoplankton parameters values occurred mainly in the eutrophic area (S1) between the two sampling periods. During 1982-1983 exceptionally high concentrations of chlorophyll *a* and phytoplankton cells were recorded at station S1 in comparison to values either from the same station during 1989-90, or from station S2 for both years. These differences can be attributed to the lower values of nutrients (NO^-_3-N, PO^{-3}_4-P, Table 1) recorded during 1989-90 at the eutrophic station S1, caused rather from the unstable character of this eutrophic environment, than from a better control of the effluents.

Station	Temperature (°C)	Salinity (ppt)	DO ml/(l)	NO^-_3-N (µg-at/l)	PO^{-3}_4-P (µg-at/l)	Chl-a (µg/l)	Total cells (cells/l)
A. April 1982 - March 1983							
S_1	12.90-26.00 18.98	36.67-38.69 37.44	2.75-7.21 4.33	0.07-6.13 1.94	0.05-4.20 1.37	0.10-84.25 12.19	$2.9X10^4$-$1.9X10^7$ $3.1X10^6$
S_2	12.80-25.2 18.81	36.69-38.49 37.51	2.80-6.11 4.69	0.18-1.54 0.59	0.05-0.27 0.13	0.10-2.17 0.51	$4.0X10^3$-$2.4X10^5$ $4.5X10^4$
B. April 1989 - March 1990							
S_1	13.61-24.87 18.82	37.49-38.73 38.23	3.98-5.96 5.05	0.17-1.24 0.59	0.03-4.53 0.84	0.31-9.35 2.85	$2.2X10^4$-$7.0X10^5$ $4.0X10^5$
S_2	13.93-25.14 19.29	38.22-38.72 38.46	4.60-5.83 5.21	0.10-0.49 0.27	0.03-0.76 0.14	0.10-1.66 0.61	$8.6X10^3$-$3.0X10^6$ $8.3X10^5$

Table 1. Range and mean values of selected hydrographic and biological parameters in 1m depth of Saronikos Gulf, during the periods April 1982-March 1983 (PAGOU and IGNATIADES, 1988; PAGOU, unpublished data) and April 1989 -March 1990 (NCMR, 1991).

The annual cycles of chlorophyll *a* (Fig. 1) have been altered from the pattern previously described and maxima were recorded in summer (June), at the eutrophic station S1, during both sampling periods, whereas at station S2, maxima were recorded both during spring (March 1983, 1990) and summer (June 1983). From the above presented and discussed data, it is obvious that differences had occurred, concerning the annual cycles of phytoplankton between stations and sampling periods. Thus numerical taxonomy (MDS - stress : 0.130, Fig. 2) was used in order to assess whether these differences are significant and to test if a seasonal grouping of the phytoplankton samples exists, according to the presence and abundance of phytoplankton groups. At the similarity level of 70% two groups were distin-guished (Fig. 2): a) Group 1 consisted only from some 1982-83 samples from both stations, i.e. autumn samples (August, September, October 1982) from station S1 and various sam-ples from station S2, originating throughout the first sampling period (April, May, June, July, September, October, November, December 1982). The samples of group 1 were characterized by low abundances of µ-flagellates and "others" and intermediate of all other groups. b) Group 2 was con-structed from all the remaining samples from the first period and the samples from 1989-90. However in group 2, two well defined subgroups could be described. The first subgroup (2A) joined samples from spring to late summer, from both stations and sampling periods (S1: June, July 1982, April, June, September 1989, March 1990, S2: April, September 1989), having as dominant groups mostly dinofla-gellates and µ-flagellates. Mainly winter samples (S1: December 1989, S2: January February 1983, June, December 1989) were contributing to the formation of the second subgroup (2B) and were characterized by almost equal predominance of diatoms, dinoflagellates and coccolitho-phorides, along with relatively high abundances of µ-flagellates and "others". The conclusion that could be drawn from the above data analysis, for both sampling periods, is that discrepancies have been occurred on the seasonal cycles of phytoplankton groups in both eutrophic and oligotrophic areas, which have altered the succession pattern of phytoplankton, although in different ways for each period. This conclusion is in agreement with the hypothesis that though phytoplankton community responds to changes in the physicochemical environment, other factors such as climatological changes can also act as a "stress" factor on the ecosystem, and pollution alone cannot explain the observed differences (GREVE and PARSONS, 1977).

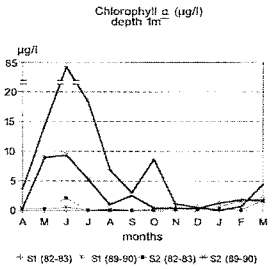


Fig. 1. Annual cycles of chl *a* (mg/l, 1 m depth)

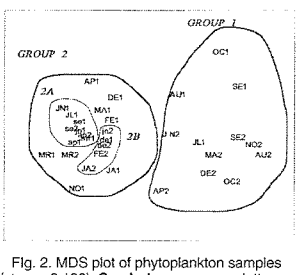


Fig. 2. MDS plot of phytoplankton samples (stress: 0.130). **Symbols:** upper case letters = months of 1982-83, lower case letters = months of 1989-90, 1 = station S1, 2 = station S2.

REFERENCES

FRILIGOS N., 1985. *Water Res.*, 19: 1107-1118.

GREVE W. and PARSONS T.H., 1977. *Helgolander wissenschaftliche Meeresuntersuchungen*, 30: 666-672.

IGNATIADES L., 1969. *Mar. Biol.*, 3(3): 196-200.

KLARKE K.R. and GREEN R.H., 1988. *Mar. Ecol. Prog. Ser.*, 46: 213-226.

NCMR, 1991. Monitoring of biological parameters in Saronikos Gulf. April 1989-March 1990. Techn. Report. 163 pp

PAGOU K. and IGNATIADES L., 1988. *Biol. Ocean.*, 5: 229-241.

SEASONAL VARIABILITY OF NANO- AND MICROPLANKTON IN HERAKLION BAY (SOUTH AEGEAN)

Paraskevi PITTA[1] and Antonia GIANNAKOUROU[2]

[1] Institute of Marine Biology of Crete, P.O. Box 2214, 710 03 Heraklion, Greece
[2] Station de Biologie Marine, 34200 Sète, France

Plankton community dynamics, in the Eastern Mediterranean, and especially as far as microzooplankton is concerned, has hardly been studied. A regular sampling programme was undertaken in order to study the structure of the nano- and microplankton communities in the Gulf of Heraklion over four distinct periods as well as the intra-annual differences in species composition. To this end, samples were collected between 15/1 and 26/2/1992 (winter), 17/4 and 19/5/1993 (spring), 1/6 and 3/7/1993 (summer), 4/11 and 6/12/1993 (autumn). Sampling was conducted on the surface layer of the coastal sea area every fourth day, using a 10 l recipient. The samples were preserved with acidic Lugol's iodine and stored at 4°C until examination under an inverted microscope. Counts and identification of planktonic organisms (diatoms, flagellates, dino-flagellates, ciliates and rotifers) were carried out with the Utermöhl method, to the species level. These data were analysed using Multi-dimensional scaling (MDS) (FIELD *et al.*, 1982) with a log(x+1) transformation and Canberra similarity index. The two dimensional MDS plot (Fig.1) reveals a pattern corresponding to seasonal differences in the structure of plankton communities. It can clearly be seen that winter and autumn samples form two separate clusters while spring and summer communities are grouped together in a third cluster. The high community similarity between spring and summer can be attributed to the similar environmental conditions (light intensity, temperature, nutrients concentration) during this period. Figure 2 shows the quantitative data at the group level, i.e. the average abundance as well as the total species number of diatoms, dinoflagellates, ciliates and rotifers. Flagellates are not included in this histogram because their enumeration was based on size classes. It is apparent that at this group level three combinations are distinguished: high diatom-low dino-flagellate (winter), low diatom-high dinoflagellate (spring-summer) and low diatom-moderate dinoflagellate (autumn). In comparison to the above mentioned groups, ciliates are of minor quantitative importance although they present a noticeable species richness. Diatoms presented maximal abundance in winter samples (highest value 13 480 cells/l) with dominant species *Nitzschia delicatissima, N. seriata* and *Leptocylindrus danicus*. Dinoflagellates were particularly abundant in spring and summer (maximal abundance 10 340 cells/l and 7 640 cells/l respectively) and less abundant in autumn (4 280 cells/l max. value). The highest density (592 000 cells/l), recorded in a summer sample, was monopolized by a *Peridinium trochoideum* bloom. Two rotifer species (*Synchaeta triophthalma* and *Trichocerca sp.*) were found. Rotifers' abundance was detectable only during spring and summer. The highest density counted was 780 *S. triophthalma*/l in a summer sample while the usual abundance, during spring and summer was 20 ind./l. Overall, 30 plankton ciliate species were identified: 10 Tintinnina and 20 Oligotrichina species. Ciliates presented a higher number of species in spring and summer while their maximal abundance was recorded during summer. The dominant ciliate species were *Strombidium conicum, S. parvum, S. vestitum, Favella azorica* and a tiny *Strombidium sp.* In comparison to seasonal phytoplankton data from Saronikos Gulf (IGNATIADES, 1969) our data presen-ted higher abundance of dinoflagellates and less pronounced seasonal differences in diatoms abundance as well as qualitative differences in phytoplankton com-munity composition. These differences might be related to the pro-ximity of Crete to the subtropical zone as well as to the fact that in the near shore zone, the fluctuation of nutrients throughout the year is less dramatic than in more offshore systems.

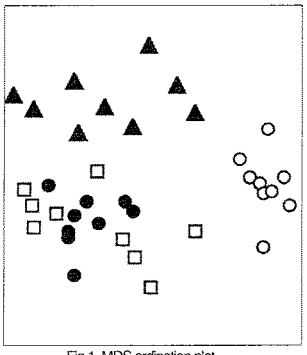
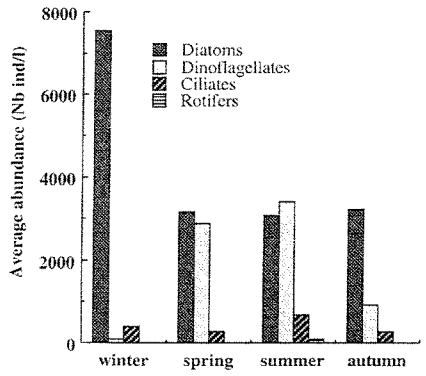


Fig.1. MDS ordination plot
○winter spring ●
□summer autumn ▲



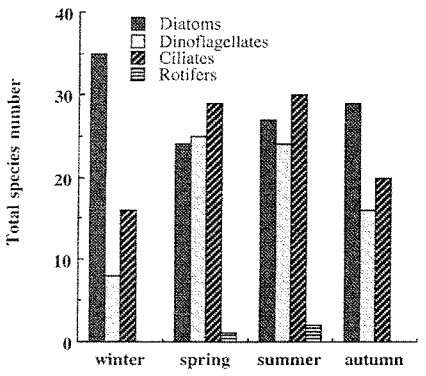


Fig. 2. Average abundance (in all 9 samples) and total species number (over 9 samples) of plankton groups over the four seasons.

REFERENCES

FIELD J.G., CLARKE K.R. and WARWICK R.M., 1982. A practical strategy for analysing multispecies distribution patterns. *Mar. Ecol. Prog. Ser.*, 8: 37-52.

IGNATIADES L., 1969. Annual cycle, species diversity and succession of phytoplankton in lower Saronicos Bay, Aegean Sea. *Mar. Biol.*, 3(3): 196-200.

P

RÉPARTITION ET COMPORTEMENT DES CRUSTACÉS DÉCAPODES DANS DEUX RÉGIONS DE LA MÉDITERRANÉE : LE BASSIN ALGÉRIEN ET LA MER ADRIATIQUE

Rabia SERIDJI[1] et Serge DALLOT[2]

[1] Institut des Sciences de la nature, Alger. Algérie
[2] Station zoologique, Ecologie et biologie du plancton, Villefranche s/mer, France

Les échantillons de larves de crustacés décapodes qui font l'objet de ce travail ont été obtenus au cours de deux campagnes sur la recherche des oeufs et larves des thonidés dans les secteurs central et oriental des côtes algériennes (16 stations) et dans le secteur sud de l'Adriatique septentrionale et moyenne (32 stations). Les côtes algériennes du secteur central sont caractérisées par un talus continental étroit avec une pente très abrupte où les fonds de 100 m sont à moins de 100 milles marins des côtes. En outre, c'est dans ce secteur que le courant algérien devient instable et forme des tourbillons dont la plupart sont anticycloniques (MILLOT, 1985; MILLOT *et al.*,1986). Dans le secteur oriental, le talus continental descend en pente douce sur une grande distance. Dans cette région, les structures turbulentes du courant algérien s'atténuent et commencent à s'éloigner des côtes. Au contraire, le secteur sud de l'Adriatique septentrionale est peu profond (<75 m), avec des fonds sableux et reçoit des grandes quantités d'eau douce grâce au Pô. Dans l'Adriatique moyenne, les fonds s'abaissent doucement vers la fosse de Jakuba (= 280 m); ils sont caractérisés par des argiles et des limons. Les côtes occidentales sont basses tandis que les côtes orientales sont découpées et les pentes abruptes plongent directement dans la mer sans aucune indication de falaise ou de plate-forme littorale. Selon ZORE-AMANDA (1969) et ORLIC *et al.*, (1992), la circulation générale de surface consiste en un méandre cyclonique à grande échelle de direction nord le long des côtes orientales et qui descend vers la Méditerranée en longeant les côtes occidentales. Cette circulation varie avec les saisons.

Nous avons réalisé :

1- une analyse des coordonnées principales. Seules les espèces larvaires ayant 5 à 9 présences ont été retenues (27 espèces pour les côtes algériennes et 41 pour l'Adriatique moyenne). Nous avons ensuite procédé à l'analyse des données en modes Q après avoir effectué le calcul de la distance de corde entre stations. Le choix de ce coefficient est justifié par le caractère non standardisé des pêches qui correspondent à des volumes filtrés très disparates et par l'absence de significations réelles des co-absences qui sont sans effet sur les distances calculées. Pour l'Adriatique, nous avons aussi utilisé la distance de Canberra afin que les espèces les plus abondantes contribuent beaucoup moins à la distance et davantage à la similarité.

2- des dendogrammes par la méthode de classification hiérarchique agglomérative en calculant les distances entre groupes pris 2 à 2 selon la méthode de LANCE et WILLIAMS (1967) avec Alpha = 0,625, Bêta -0,25 et Gamma = 0.

Résultats :

1- Côtes algériennes. Les résultats de l'ordination ainsi que ceux obtenus par la CHA concordent et mettent en évidence 3 groupes de stations à composition méroplanctoniques voisine (A,B,C). En outre, ils montrent l'importance prédominantes des profondeurs du fonds aux stations liées au caractère pélagique des peuplements. L'axe 1 code pour la profondeur. Le groupe A s'oppose aux groupes B et C. L'axe 2 code pour la nature du biotope parental. En effet, à une extrémité, nous trouvons les stations 1 et 2 de la région d'Alger caractérisées par des larves d'espèces pélagiques en majorité et quelques larves d'espèces benthiques du domaine néritique correspondant à la baie de Skikda. Le dendogramme concorde globalement avec l'ordination selon les axes 1 et 2. Le groupe A s'oppose bien aux groupes B et C.

2- Adriatique. L'ensemble est plus homogène que dans la collection algérienne. Ce qui semble normal de par la topographie, la bathymétrie, la nature des fonds ainsi que l'hydrologie. Aussi, les résultats obtenus par la CHA et par l'ordination présentent un caractère régional accusé. Dans un graphique de l'ordination en espace réduit selon les axes 1 et 2, nous avons délimité les groupes tels qu'ils ont été constitués par la méthode de CHA. Signification de l'axe 1 : les stations 11 et 12 s'opposent aux stations 3 et 9 selon l'éloignement de la côte italienne vers la côte dalmate. Cet axe code pour la distance par rapport aux côtes italiennes. Signification de l'axe 2 : les stations 13, 15, 28 s'opposent aux stations 2 et 4 selon la nature des fonds; les stations 2 et 4 sont au-dessus de fonds plus argileux. Le dendogramme obtenu met en évidence 7 groupes. Le groupe A réunit les stations non loin des côtes dalmates de l'Adriatique moyenne, elles sont situées à des profondeurs entre 100 et 200 m pour celles qui se trouvent à proximité de la fosse de Jakuba au-dessus de fonds meubles argilo-limoneux. Le groupe B est formé de 2 sous-groupes spatialement éloignés, ayant des distances de Canberra voisines. Les stations de ce groupe sont situées à des profondeurs moyennes (75 à 120 m) au-dessus de fonds meubles argilo-limoneux. Le groupe C est en position centrale au-dessus de substrats meubles peu profonds; le groupe D ressemble au groupe précédent. Le groupe E regroupe la plupart des stations de l'Adriatique septentrionale (sect. Sud) au-dessus de fonds sableux de 50 m de profondeur. Le groupe F est strictement localisé aux faibles profondeurs de la côte italienne entre Pesaro et Pescara. Le groupe G regroupe également les stations au-dessus de faibles profondeurs au sud de Pescara et du seuil de Palagruz.

En conclusion, le peuplement de larves de crustacés décapodes des côtes algériennes présente un faciès nettement pélagique. Ceci est d'abord en rapport avec le développement indirect à phase planctonique plus ou moins allongée de presque tous les crustacés décapodes (benthiques et pélagiques). Ces larves se comportent de manière passive vis-à-vis du courant algérien qui tend à les entrainer vers le large (groupe A et C). Au contraire, les populations larvaires de l'Adriatique septentrionale (secteur sud) et de l'Adriatique moyenne sont plus homogènes et caractérisent une mer peu profonde avec un substrat quasi-uniforme et subissant les influences continentales.

RÉFÉRENCES

LANCE G. et WILLIAMS W.T. 1967. Mixed data classificatory programs- 1 : agglomérative systems. *Aust. Comp. J.*, 1 : 15-20.

MILLOT C. 1985. Some features of the Algerian current. *J. Geophys. Res.* 90 (C4) : 7169-7176.

MILLOT C., TAUPIER-LETAGE I. et BENZOHRA M. 1990. The Algerian eddies. *Earth Sciences Rev.*, 27 : 203-219.

ORLIC M., GACIC M. et LA VIOLETTE P.E. 1992. The currents and circulation of the Adriatic sea. *Oceanol. Acta.* 15 (2) : 109-124.

ZORE-ARMANDA M. 1963. Les masses d'eau de la mer Adriatique. *Acta Adriatica*, 10 (3) : 1-94.

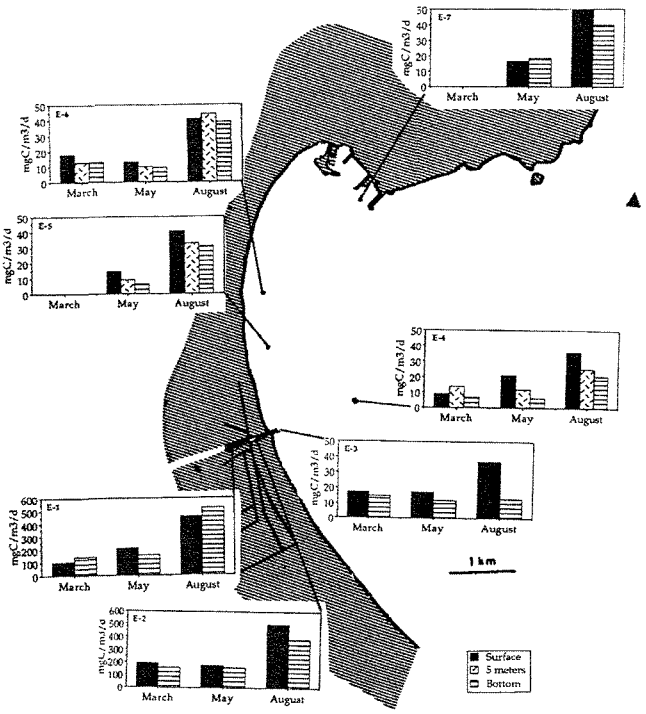
PHYTOPLANKTONIC PRIMARY PRODUCTION IN AN INTERACTION ZONE BETWEEN EPICONTINENTAL AND MARINE SYSTEMS

E. SINTES[1], B. AMENGUAL[2], V. FORTEZA[1], C. FRAU[1], A. MARTÍNEZ-TABERNER[1], J. MARCH[1], F. MIR[1], G. QUETGLAS[1], G. RAMÓN[1], B. REVIRIEGO[1], G. MOYÀ[1]

[1] Dpt. Biologia Ambiental, Univ. Illes Balears, 07071 Palma de Mallorca, Spain
[2] Centro Oceanográfico de Baleares, Palma de Mallorca, Spain

The hydrology and phytoplankton community activity have been studied, by means of monthly samples, in an interaction zone between a coastal marsh system, the Albufera of Mallorca, and the sea, at the Alcudia Bay. Vertical profiles were carried out at seven stations, two (E-1 and E-2) in the canal leading to the bay (maximum depth 1 m) and five (E-3, E-4, E-5, E-6 and E-7) within the bay (maximum depth 15 m). Primary production measurements have been realized for many time to evaluate phytoplankton activity in the sea (SOURNIA, 1973) as well as in coastal lagoon (f.ex. COMÍN and VALIELA, 1993). This parameter was measured at three moments of the year (March, May and August) for this study. The Albufera waters are rich in nutrients, chiefly nitrates (values exceeding 100 µg-at. $N\text{-}NO_3^-$ l^{-1}), as a result of agricultural fertilizers. This results in very high values in phytoplankton primary production, between 100 and 500 mg C m^{-3} d^{-1}, and assimilation numbers between 3 and 16 mg C mg Chl*a*$^{-1}$ h^{-1}. Nutrient export to the bay enhances phytoplankton proliferation in two ways: either rapidly by massive input of water, or on a longer term as a result of deposition and slow nutrient recycling from the sediment (MOYÀ *et al.*, 1992). Nevertheless primary production values in the bay, between 5 and 50 mgC m^{-3} d_{-1}, are about ten times lower than in the Albufera throughout the sampling period. In this zone the assimilation number varies in a lower range, between 2 and 10 mg C mg Chl*a*$^{-1}$ h^{-1}. Biomass and phytoplankton primary production are related in both the Albufera and the bay, and can be related to environmental fluctuations. Primary production maxima coincide in both systems and take place during the summer (figure 1). These maxima coincide with biomass maxima, expressed as chlorophyll *a* concentration, which present values between 2.5 and 5.8 mg m^{-3} in the Albufera, and between 0.4 and 0.9 mg m^{-3} in the bay. Results suggest that in the interaction zone between the Albufera and the bay primary production is kept high throughout the cycle, even though significant differences may be attributed to environmental conditions such as nutrient concentration and phytoplankton biomass. Values obtained for the bay are comparable to those of oligotrophic waters (MARGALEF, 1989), while those of the Albufera fall within the range of mesotrophic-eutrophic waters. Results in the stations of Gran Canal in the Albufera experiment an evolution throughout the cycle similar to that observed in the Ebro Delta lagoons (COMÍN and VALIELA, 1993), where phytoplanktonic primary production was low from fall to winter, showed a very low production rates in May and increased in June-July (in Encanyissada).

Figure 1. Primary production values, in mg C m^{-3} d^{-1}, at the differents stations (E-1 and E-2 at the Albufera, and E-3 to E-7 at the Alcudia Bay) and levels throughout the three sampling times (March, May and August).



This work has been supported by the project C.I.C.Y.T. AMB. 92-0716-002-01 of the Spanish Comisión Interministerial de Ciencia y Tecnología (Ministry of Education and Science).

REFERENCES

COMIN, F.A. and VALIELA, I. 1993. On the Controls of Phytoplankton Abundance and Production in Coastal Lagoons. *Journal of Coastal Research.* 9 (4): 895-906.

MARGALEF, R. 1989. Ecología. Ediciones Omega. 951 pp. Barcelona.

SOURNIA, A. 1973. La production primaire planctonique en Méditerranée, essai de mise à jour. *Bulletin de l'étude en commun de la Méditerranée.* 5: 1-128.

MOYA, G., FERNANDEZ DE PUELLES, M.L., FORTEZA, V., FRAU, C., MARTINEZ, C., MARTINEZ TABERNER, A. and VIVES, F. 1992. Relationships between physico-chemical characteristics and planktonic communities in the Bay of Alcudia (Majorca). *Rapp. Comm. int. Mer Médit.*, 33: 262.

VARIABILITÉ DU CYCLE ANNUEL DU ZOOPLANCTON DANS LA BAIE D'ELEFSIS (GRECE)

I. SIOKOU-FRANGOU and E.D. CHRISTOU
Centre National de Recherches Marines, Ag.Kosmas, 16604 Athènes, Grèce

La baie d'Elefsis, peu profonde, semi-fermée et située au nord du golfe de Saronikos, constitue un milieu pollué par les rejets urbains, industriels et navals. Le renouvellement des eaux y est lent (deux mois) et durant l'été une forte stratification est observée en même temps que des conditions anoxiques au-dessous de 20 m. En vue d'étudier le zooplancton dans cette région, des échantillons ont été collectés à une station (38°N 23°27 E). L'échantillonnage (mensuel durant les années 84, 85, 87 et 89-90) a été effectué par trait oblique d'un filet WP-2 (200 µm) du fond de la mer (28 m) à la surface. L'étude des fluctuations de l'abondance zooplanctonique et de la composition spécifique ont fourni des données concernant le cycle annuel du zooplancton. Les fluctuations de la biomasse, exprimée en mg/m^3 (fig.1), sont autant mensuelles qu'interannuelles. Les différences entre les années ne sont pas significatives selon les résultats de l'analyse de variation des données. En gros, le cycle annuel est caractérisé par de hautes valeurs (60 à 470 mg/m^3) en janvier-mars qui diminuent au printemps. Des maxima hivernaux n'ont pas été observés en 1987, fait qui pourrait être liée a l'abondance précoce de la méduse *Aurelia aurita*, le prédateur principal du mésozoo-plancton dans la baie (PANAYOTIDIS *et al.*, 1988). Les hautes valeurs sont exclusivement dues à l'abondance massive du copépode *Acartia clausi* qui représente plus du 95% du zooplancton total. En été et en automne, la biomasse est basse avec quelques exceptions (sept. 84, août 85, nov. 87) mais ces valeurs ne dépassent pas 60 mg/m^3.

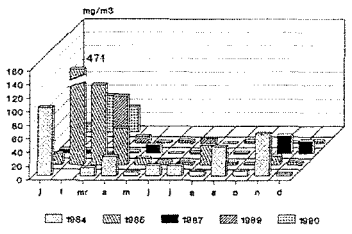


Fig.1. Fluctuations de la biomasse zooplanctonique

Les variations de la composition spécifique sont claires sur le plan des axes 1*3 de l'analyse des correspondances (fig.2). Les projections des mois de la période janvier-mai des années 84, 85,89 et 90 coïncident, ainsi que la projection d'*A. clausi* (*acl*). En 1987 et 1989, la dominance d'*A. clausi* s'est étendue jusqu'en juin. Une différentiation a été observée en janvier 85 et février 87 où l'abondance d'*A. clausi* a diminué tandis que celle des larves de gastéropodes (jan. 85) et du cladocère *Podon polyphemoides* (*ppo*) (fév. 87) était importante. Etant donné qu'une grande abondance d' *A. clausi* a été observée pendant la même période lors des années 1972-74 (YANNOPOULOS, 1976), on pourrait considérer ce fait comme une constante du cycle annuel zooplanctonique de la baie d'Elefsis. Au contraire, les projections des mois estivaux et automnaux sont parsemées le long du troisième axe et en outre il n'y a pas toujours de coïncidence interannuelle. En été et en automne 84, la communauté zooplanctonique a été caractérisée par la dominance du cladocère *Penilia avirostris (pea)*, accompagné d'*Evadne tergestina* (evt) en été et de *P. polyphemoides* en automne. Lors des années suivantes, le peuplement estival a été caractérisé par les copépodes suivants : *Paracalanus parvus (ppa), Centropages ponticus (cep), Temora stylifera (tes), Acartia latisetosa (ala)*, mais *Acartia grani (agr)* n'est paru en abondance qu'à l'été 89. Les échantillons d'automne (oct.- déc. 85 et déc. 89) se distinguent par la forte dominance (50-90%) de *P. polyphemoides*. Par ailleurs, une présence importante de l'appendiculaire *Fritillaria haplostoma (frh)* a été signalée en octobre 85 (21%) et en décembre 89 (45%). Il en résulte une différence le long du 3e axe entre les échantillons d'automne 85 et 89 et ceux de l'été correspondant.

En conclusion, on pourrait dire que le cycle annuel du zooplancton de la baie d'Elefsis est caractérisé par une certaine constance en hiver et au printemps et par une forte variabilité en été et automne. Les études antérieures dans la région, concernant la couche superficielle, ont révélé une abondance d'*A. clausi* et d'*Oithona nana* en hiver-printemps et de *P. avirostris* et d'*Oithona nana* en été-automne (MORAITOU-APOSTOLOPOULOU & IGNATIADES, 1980). Certains aspects de ce cycle (dominance d'une ou deux parmi les espèces *A. clausi, P. polyphemoides, P. avirostris, E. tergestina*) sont pareils à ceux observés dans d'autres régions polluées : le golfe de Trieste (SPECCHI *et al.*, 1981), le golfe d'Izmir (OZEL & MAVILI, 1990), le golfe de Thessaloniki (SIOKOU-FRANGOU & PAPATHANASSIOU, 1991). Le cycle saisonnier de ces espèces ne coïncide pas d'une région à l'autre; cependant le cycle de l'année 85 dans la baie d'Elefsis a été plus ou moins similaire à celui observé dans le golfe de Fos en 80-81 (PATRITI, 1984). La variabilité du cycle du zooplancton dans la baie d'Elefsis doit être liée à la variabilité des facteurs de l'environnement qui dépendent des activités humaines. Les fluctuations des sels nutritifs ne présentent pas le cycle saisonnier méditerranéen (FRILIGOS, 1981) et par conséquent le phytoplancton présente un cycle perturbé (PAGOU & IGNATIADES, 1988) et une variabilité interannuelle (PAGOU, 1991).

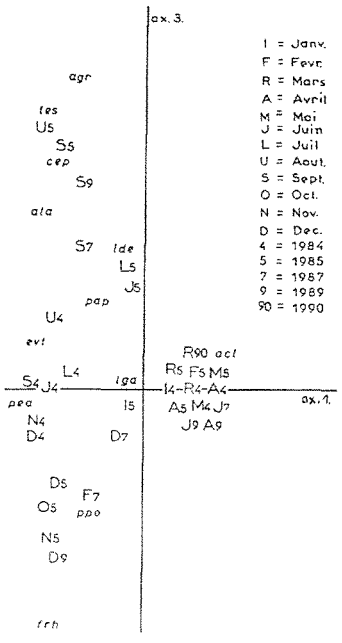


Fig.2 : analyse des correspondances, graph.1*3

REFERENCES

FRILIGOS, N., 1981. *Mar. Pol. Bull.* 12(12):431-436.

MORAITOU-APOSTOLOPOULOU, M. & L.IGNATIADES, 1980. *Hydrobiol.* 75:259-266.

OZEL,I. & S.MAVILI, 1990. *Rapp. Comm. int. mer Medit.* 32(1): 222.

PAGOU, K. & L. IGNATIADES, 1988. *Biol. Oceanogr.* 5:229-241.

PAGOU, K., 1991. Monitoring of biological parameters in Saronikos gulf, Techn. Rep. NCMR.

PANAYOTIDIS,P. E.PAPATHANASSIOU, I. SIOKOU-FRANGOU, K.ANAGNOSTAKI & O.GOTSIS-SKRETAS, 1988. *Thalasso.* 11(1): 7-17.

PATRITI,G., 1984. *Tethys* 11(2): 155-161.

SIOKOU-FRANGOU,I. & E.PAPATHANASSIOU, 1991. *Mar. Ecol. Progr. Ser.* 76:41-51.

SPECCHI,M., S.FONDA-UMANI & G.RADINI, 1981. *Rapp. Comm. int. mer Medit.* 27(7):97-99.

YANNOPOULOS, C., 1976. *Rapp .Comm. int. mer Medit.* 23(9) : 107-108.

TEMPORAL VARIABILITY OF BIOLOGICAL PARAMETERS IN THE NORTHWESTERN MEDITERRANEAN

I. TAUPIER-LETAGE[1], C. MILLOT[1], P. CONAN[1], T.D. DICKEY[2], D. MANO[2], D. FOLEY[2]

[1] Centre d'Océanologie de Marseille, CNRS, La Seyne, France
[2] University of Southern California, Los Angeles, USA

Although the spatial heterogeneity of the distribution (patchiness) of phytoplanktonic biomass is now commonly investigated, data concerning its temporal variability over long periods of time are still very sparce (see DICKEY *et al.*, 1992). This is first because of limited technologies, and second because no water color satellite is flying yet to replace the Coastal Zone Color Scanner. Such information is crucially needed though to correctly describe and quantify the variability of the biological parameters, and to investigate relations between dynamical and biological phenomena. A CNRS/NSF cooperation between the COM and USC has enabled us to obtain concurrent time series of biological and dynamical parameters for the first time in the Mediterranean, achieving one of EUROMODEL's objectives. From September 13 to November 10 1993, at a site approximately 10 nautical miles south of Marseilles, the BIOVAR mooring with 4 autonomous fixed-depth instruments Multi Variable Moored Sensors (MVMS, cf Fig. in DICKEY and TAUPIER-LETAGE, 1990) recorded every 4 minutes, the following parameters at 40, 50, 60 and 80 m (no data return from the 60 m MVMS, which was damaged): horizontal currents, temperature,conductvity, stimu-lated fluorescence of chl.*a*, natural fluorescence of chl.*a*, beam attenuation coefficient (c660nm), dissolved oxygen, and PAR (Photosynthetically Active Radiation). The BIOVAR experiment was part of the French Programme National d'Océanographie Côtière (PNOC), for which a transect (7 stations) crossing the Northern Current (MILLOT, 1991) at the entrance of the Gulf of Lions has been regularly sampled with CTD casts and concurrent determinations of nutrients, chlorophyll *a*, organic matter, and dissolved oxygen. Additionally, C^{14} *in situ* incubations ("Let Go") have been performed at station M3 for primary production estimations. During the fall of 1993, the weather was characterized by many strong wind events and heavy showers. Thus, our records might not be representative of typical fall conditions when there is commonly a secondary phytoplanktonic bloom. However, there was a high degree of variability as expected. For instance, there were several episodic dramatic increases in temperature (≈5°C at 40 and 50 m) related to meanders of the Northern Current, and the destruction of the thermocline at the end of October (Fig.1). Diel variations were observed in chlorophyll concentration records, as well as variations on a time scale of a few days (e.g. from 0.2 to 0.8 µg/l on Sept. 16 -17 at 50 m, Fig.2). The present data set will be used to model primary production, and to derive significant means and variances of bio-optical parameters. The high variability which was observed, both in time and in space in the vertical, underscores the importance of an adequate sampling strategy. It has been shown, from previous MVMS data sets that errors in estimated gross primary production resulting from shipborne sampling aliasing can reach 80% (WIGGERT *et al.*, 1994). With the increasing need for models of primary production at basin and global scales, we need to have, in a dynamical context, a good description of the biologically-related parameters and more specifically, of their variability, in order to provide and to validate models with sound parameters. As a consequence, efforts must be made to develop autonomous multivariable instrumentation, especially in the profiling mode to achieve good vertical resolution, and to expand our observational database.

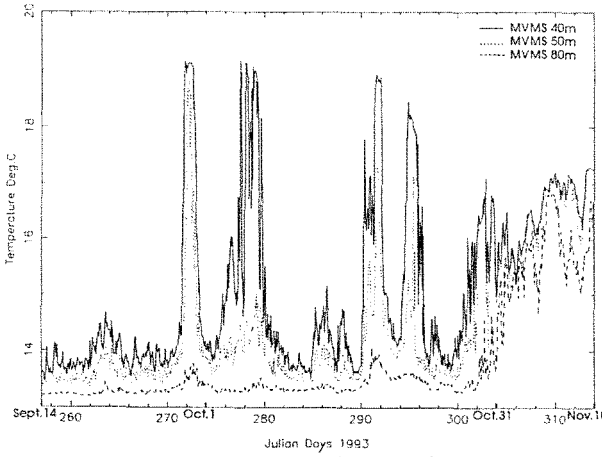


Fig.1: BIOVAR mooring: superimposed time series of temperature

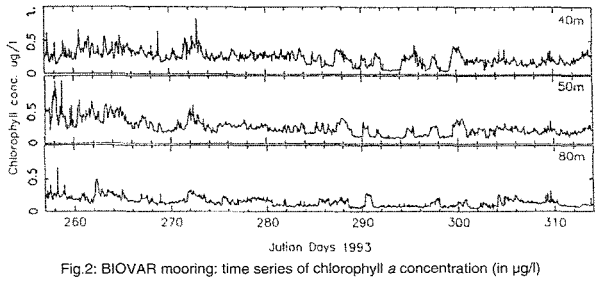


Fig.2: BIOVAR mooring: time series of chlorophyll *a* concentration (in µg/l)

REFERENCES:

T. DICKEY and I.TAUPIER-LETAGE, 1990. Recent advances and future directions in concurrent time series observations of physical, optical, biological and geochemical processes. *Rapp. Comm. int. Mer Medit.* 32,1 : 282.

T. DICKEY, T.GRANATA and I.TAUPIER-LETAGE, 1992. Automated in situ observations of upper ocean biogeochemistry, bio-optics, and physics and their potential use for global studies. Proc. of the Ocean Climate Data Workshop, GSFC, Maryland, Feb. 18-21 1992, 317-353.

MILLOT C., 1991. Mesoscale and seasonal variabilities of the circulation in the Western Mediterranean. *Dyn. of Atm. and Oceans*, 15, 179-214.

WIGGERT J., T.DICKEY and T.GRANATA, 1994. The effect of temporal undersampling on primary production estimates. *J. Geophys. Res.*,99, C2 :3361-3371.

P

PHYTOPLANKTON AND OCEANOGRAPHIC CONDITIONS IN THE STRAIT OF OTRANTO (EASTERN MEDITERRANEAN)

VILICIC D.[1], LEDER N.[2], GRZETIC Z.[2], JASPRICA N.[1]

[1] Biological Institute, P.O.Box 39, 50001 Dubrovnik, Croatia
[2] Hydrographic Institute of the Republic of Croatia, P.O.Box 219, 58000 Split, Croatia

The Strait of Otranto is the connection between the Adriatic and Ionian Seas. The present knowledge of biological characteristics in the Strait is poor. Other natural characteristics relate mainly to water circulation and thermohaline characteristics.

Water samples (5 l Niskin bottles at 0.5, 5, 10, 20, 50, 75, 100 and 200 m) were collected during five spring-summer case studies (March 1990, April 1987, May 1990, July 1989, August 1986), with the RV "Andrija Mohorovicic", from two stations located across the Strait : the western station 4 and the eastern station 2 (Fig. 1). T-S characteristics were determined with TCD probe. Current measurements were performed in March and May 1990. Maximum thermic gradient of 0.35°C m^{-1} was found along the thermocline in the 10-30 m layer in July and August. Surface salinity values were lower in summer than in spring. Concentrations <0.2 μmol l^{-1} PO4, <2 μmol l^{-1} NO_3, <0.17 μg chl. *a* l^{-1}, 15-36 m Secchi disc visibility, reflect an oligotrophic character of the area (Tab. 1). The most abundant microphytoplankton (MICRO) species were diatoms (7 1 determined species). Dinoflagellates provided high species diversity (73 species), but low population density (mostly ≤10 cells l^{-1}). Diatoms (mostly small cell sized populations) dominated in the total MICRO abundance (43-99%). Relatively higher percentages of coccolithophorids, dinoflagellates and >3000 μm^3 cell-1 diatom fraction were recorded in August 1986. Subsurface chlorophyll maxima were found in the 50-100 m layer. Size fraction <20 μm dominated total phytoplankton biomass. In April and May subsurface accumulation of MICRO cells were also determined (Fig. 1). In summer the reduced MICRO densities are the result of the depletion of nitrate concentrations.

The eastern part of the Strait is mostly influenced by the northerly inflowing current from the Ionian Sea and the western part by the southerly outflowing current from the Adriatic Sea (typical circulation). The most intensive currents were usually recorded between 200 and 500 m with velocities of up to 64 cm sec^{-1}. Slower inflowing/outflowing currents (2-49 cm sec^{-1}) were recorded in the 0-100 m layer. Temperature and salinity values were generally lower, while abundance of MICRO and dinoflagellates higher at the western station 4, indicating southerly outflowing current there. An typical circulation could be disturbed by meteorological factors. Phytoplankton distribution was influenced by currents and complex hydrodynamic conditions. In April and May, differences in east-west distribution of thermohaline characteristics and phytoplankton were significant but due to atypical circulation in the Strait. In April 1987, this might be explained by the occurrence of the cyclonic eddy in the Strait, as have been observed from the satellite images (ARTEGIANI *et al.*, 1993), and stronger inflow of modified Levantine intermediate water into the Adriatic Sea. In May 1990, inertial oscillations in the current field were generated by the strong oscillating wind, resulting in denser phytoplankton population at the eastern station.

Thermal satellite imagery has revealed a greater horizontal thermal gradient across the Strait in winter than in summer (ORLIC *et al.*, 1992). In winter and early spring, stronger currents and east-west gradient of analyzed parameters may be expected.

	Station 4			Station 2		
	min.	max.	mean	min.	max.	mean
Temperature (°C)	13.58	26.30	16.30	13.89	26.36	16.36
Salinity (‰)	37.73	38.97	38.59	37.90	39.04	38.65
Density (σt)	25.03	29.26	28.39	25.15	29.29	28.44
Secchi (m)	15	30	22	16	36	24
PO4 (µmol l^{-1})	0.03	0.85	0.21	0.01	0.78	0.14
NO3 (µmol l^{-1})	0.07	6.68	2.04	0.04	6.85	2.29
SiO4 (µmol l^{-1})	0.06	905	3.37	0.08	7.36	2.52
Chl. *a* - total (µg l^{-1})	0.01	0.13	0.05	0.01	0.17	0.05
Chl. *a* <20 µm (µg l^{-1})	0.01	0.13	0.04	0.01	0.12	0.03
MICRO (cells l^{-1})	$1.4x10^3$	$7.1x10^5$	$1.1x10^5$	$1.4x10^3$	$2.2x10^5$	$6.0x10^4$
BACI μm^3 $cell^{-1}$	1543	158491	22222	1214	55766	9040

Table 1. Minimum (min.), maximum (max.) and mean values of analyzed parameters in the Strait of Otranto. Data for March 1990, April 1987, May 1990, July 1989 and August 1986; 0-200 m layer.

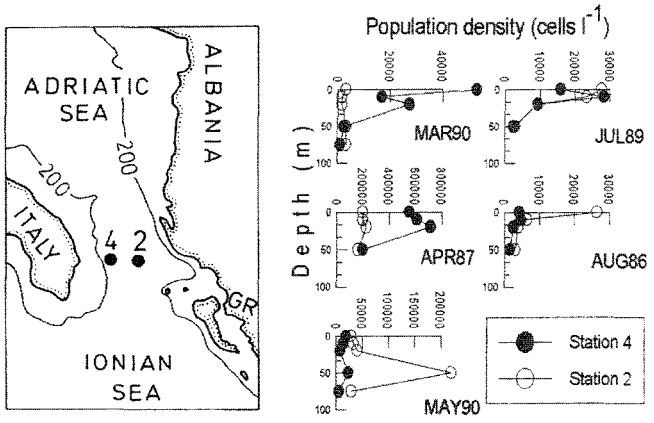


Fig. 1. Map of stations in the Otranto Strait and distribution of microphytoplankton across the Strait during five case studies (note different x-axis labels)

REFERENCES

ARTEGIANI A., GACIC M., MICHELATO A., KOVACEVIC V., RUSSO A., PASCHINI E., SCARAZZATO B. and SMIRCIC A., 1993. The Adriatic Sea hydrography and circulation in spring and autumn (1985-1987). *Deep-Sea Res.*, 40: 1143-1180.

ORLIC M., GACIC M. and LA VIOLETTE P.E., 1992. The currents and circulartion of the Adriatic Sea. *Oceanol. Acta*, 15: 109-124.

STRONG VARIABILITY OF BATHYPELAGIC ZOOPLANKTON AT A SITE IN THE LEVANTINE SEA - A SIGNAL OF SEASONALITY IN A LOW-LATITUDE DEEP-SEA?

Horst WEIKERT

Institut für Hydrobiologie und Fischereiwissenschaft, Universität Hamburg, 22765 Hamburg, Deutschland

In January 1987 and June 1993, directly comparable data sets of zooplankton were obtained from stratified oblique tows with a 1 m^2 Mocness above a 4250 m deep trough SE of Crete (34°20'N, 26°00'E). The device equipped with nine black nets of 0.333 mm mesh size was towed at a speed of about 2 knots, commencing about 100 m from the seabed. Zooplankton was defined arbitrarily to be smaller than 5 mm.

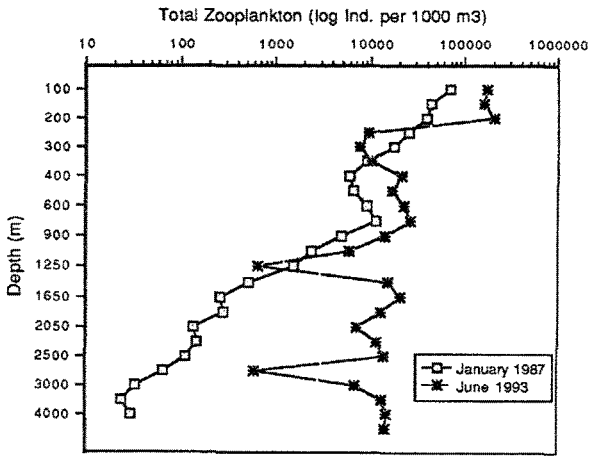
The standing crop of zooplankton was significantly higher in June (summer) than in January (winter) 1987 (Table). As examplified by one profile, the respective increase had occurred throughout the water column, but it was especially high below 1050 m, i.e. in the bathypelagic zone, as compared to shallower layers. This disproportional increase was coupled with rather constant concentrations at depth. This sort of profile contrasts to the well-known bathymetrical decrease of zooplankton at intermediate and low latitudes that was also observed at the Levantine site in January 1987 (Figure).

Overall, copepods contributed 90% to the zooplankton at both seasons. In June 1993 two calanoid species, *Calanus helgolandicus* and *Eucalanus monachus*, comprised almost 54 and 49% of the standing crops of copepods and total zooplankton, respectively (Table). Their highest absolute and relative concentrations were encountered below 600 m, and as deep as 4000 m. In this range, both species accounted for some 70% of the total zooplankton. In January 1987, *C. helgolandicus* was completely absent, and *E. monachus* constituted only 20% of the copepods and the total zooplankton each. At that time, *E. monachus* abounded between 450 and 900 m (WEIKERT and KOPPELMANN, 1993). By its abundance, this species seems to be a significant constituent of the Levantine deep-sea copepod assemblage (see also PANCUCCI-PAPADOPOULOU *et al.*, 1988) as compared to the Western Mediterranean (SCOTTO DI CARLO *et al.*, 1984).

The significant differences in the abundance and composition of zooplankton document for the first time the existence of a strong variability in a bathypelagic community at a subtropical latitude. The studied site lies in a region which is affected by a long-living anticyclonic gyre; hence at the present state of investigation, it is not clear, whether or not the observed variability is on a seasonal scale.

Standing crops of zooplankton (Individuals/m^2) at the deep site off Crete. In parentheses: relative abundances

Group/Taxon	January 1987	June 1993
Eucalanus monachus	3722 (20.0)	25706 (30.5)
Calanus helgolandicus	absent	15287 (18.0)
Total copepods	16965 (90.0)	76163 (90.5)
Total zooplankton	18865	84149



REFERENCES

PANCUCCI-PAPADOPOULOU, SIOKOU-FRANGOU I., THEOCHARIS A. and GEORGOPOULOS D., 1992. Zooplankton vertical distribution in relation to hydrology in the NW Levantine and the Aegean seas (spring 1986). *Oceanol. Acta* 15, 365-381.

SCOTTO DI CARLO B., IANORA A., FRESI E. and HURE J., 1984. Vertical zonation patterns for Mediterranean copepods from the surface to 3000 m at a fixed station in the Tyrrhenian Sea. *J. Plankton Res.* 6, 1031-1056.

WEIKERT H. and KOPPELMANN R., 1993. Vertical distribution and composition patterns of deep-living zooplankton in the NE Atlantic, the Levantine Sea and the Red Sea: a comparison. *Oceanol. Acta* 16: 163-177.

ON THE STRUCTURE OF MACROZOOPLANKTON AND ITS CONTRIBUTION TO THE ACTIVE TRANSPORT OF ORGANIC MATTER THROUGH THE UPPER PART OF THE WATER COLUMN IN THE DEEP LEVANTINE SEA

Horst WEIKERT

Institut für Hydrobiologie und Fischereiwissenschaft, Universität Hamburg, 22765 Hamburg, Deutschland

Macrozooplankton (arbitrarily defined as >0.5 cm on the basis of total length) was studied from 0.333 mm mesh size samples and discriminated into 0.5 cm size classes. The material was collected in January 1987 SE of Crete (34°20'N, 26°00'E) with the use of a $1m^2$ Mocness by oblique stratified tows which commenced at 4000 m, i.e. about 200 m from the bottom.

Overall, the composition of macrozooplankton differed markedly from that of mesozooplankton by its taxonomical and trophical nature. Copepods accounted for 90% of the total standing crop of mesozooplankton (WEIKERT and KOPPELMANN, 1993), forming a mainly omnivorous life style of this compartment by groups which are both filter and raptory feeders. Among the macrozooplankton copepods were only a minor fraction of the standing crop, constituting 0.6% and 2.8% of the smallest size class by numbers and wet weight (ww), respectively. Like in the larger fractions, carnivorous groups of swallowers such as chaetognaths, siphonophores and fishes were overwhelmingly abundant.

In the day profiles, a conspicuous change was observed for the taxonomical and trophical structure at 750 to 900 m. Chaetognaths and siphonophores, which abounded in the shallower layers, were markedly outnumbered and outweighed by crustaceans and fishes. This faunal assemblage was characterized by omnivorous feeders, mainly due to the mass occurrence of euphausiids (*Euphausia* spp.) und decapods (*Gennadas elegans*). The trophical change at depth to a more generalized omnivorous/detritivorous life style co-occurred with a change in the proportion of the standing crops of mesozooplankton and macrozooplankton. In the upper 750 m, the latter accounted for 2.2 g/m^2, i.e. 43% of the mesozooplankton, but at greater depths the macrozooplankton (1.6 g/m^2) outweighed mesozooplankton by a factor of two. Below 2250 m no macrozooplankton was caught (WEIKERT, 1990).

Nocturnal vertical migrations into the 100 m surface layer were observed for crustaceans, especially euphausiids, and large (≥1.0 cm) chaetognaths. Small chaetognaths and siphonophores showed a reversed migration pattern. For other major macrozooplankton groups no synchronous diel vertical migrations into the top 100 m could be detected.

No day/night differences were found for the biota of the 0.5-1.0 cm size class. Therefore (and in accordance to literature), this fraction was added to the mesozooplankton to estimate fluxes into the upper 100 m. The summed migrant biomasses of the macrozooplankton taxa ≥1.0 cm in size amounted to 643 mg/m^2 as compared to 194 mg/m^2 which is the day/night difference of the total macrozooplankton. The respective share of migrants to the total standing crop (704 mg/m^2) was 71% as compared to 29% in the second case, and they outweighed the migrant mesozooplankton (506 mg/m^2, day/night difference of the total mesozooplankton). Altogether, migrants comprised 42% of the combined ww of meso-/macrozooplankton in the top 100 m (2846 mg/m^2). The calculated excretion rate of nitrogen in this layer by the migrant macrozooplankton is 0.21 $mgN/m^2.d$ [0.06 $mgN/m^2.d$ when calculated from the day/night difference of total macrozooplankton], that of migrant mesozooplankton is 0.16 $mgN/m^2.d$ [using the transformations by ANGEL (1989) who assumed that dry weight [dw] = 0.13 ww, N excretion = 0.005 mg/mg.dw, residence of migrators in the top 100 m 12 hrs]. The release rate of excretory nitrogen of the non-migrant metazoans is 1.08 $mgN/m^2.d$, assuming that they stayed 24 hours in the top 100 m.

The tentative estimates of recycled nitrogen compare well with those reported by ANGEL (1989) for the zooplankton and micronekton from sites in the subtropical N-Atlantic. He suggests that totals between 1 and 2 $mgN/m^2.d$ provide for one third of the N, which is needed to support the productivity of the local deep chlorophyll-a maximum. Though the excretion rates calculated for both areas are very speculative (see ANGEL, 1989 for discussion), they indicate the non-trivial role of vertically migrating macrozooplankton in the oligotrophic Levantine Sea in January 1987. The macrozooplankton seems to redistribute similar amounts of N into the euphotic zone as compared with the mesozooplankton, while the recycling of N in this zone is mainly supported by the non-migrant mesozooplankton (0.91 $mgN/m^2.d$). Macrozooplankton probably played a principal role in the active downward transport of organic material due to the long gut retention times of large organisms. For better estimates, the assess of fluxes in the course of periodic synchronous vertical migrations should be based on the composite fluxes of the community.

REFERENCES

ANGEL M.V., 1989. Vertical profiles of pelagic communities in the vicinity of the Azores front and their implications to the deep ocean ecology. *Prog. Oceanogr.* 22: 1-46.

WEIKERT H., 1990. Vertical distribution of zooplankton and micronekton in the deep Levantine Sea. *Rapp. Comm. int. Mer Médit.* 32: 199.

WEIKERT H. and KOPPELMANN R., 1993. Vertical distribution and composition patterns of deep-living zooplankton in the NE Atlantic, the Levantine Sea and the Red Sea: a comparison. *Oceanol. Acta* 16: 163-177.

P

R

COMITÉ
RADIOACTIVITÉ MARINE

Président : Scott W. FOWLER
Vice-Président : Sezginer TUNCER

CHEMICAL PARTIONING OF PLUTONIUM AND AMERICIUM IN SEDIMENTS FROM THE PALOMARES MARINE ECOSYSTEM

M.P. ANTÓN, C. GASCÓ & M. POZUELO

Institute of Environmental Studies. C.I.E.M.A.T. Avda. Complutense 22, 28040 Madrid, Spain

The marine environment adjacent to the coastal village of Palomares (Southeastern Spain) became a suitable area to investigate the behavior of the transuranics that reached the Mediterranean Sea after the partial land-to-sea transfer of the contamination dispersed as a consequence of the non-nuclear explosion of two thermonuclear bombs accidentally released during a plane crash in 1966 (GASCÓ *et al.*, 1992 and ROMERO *et al.*, 1992). To determine the potential post-depositional remineralization of these transuranics, their bioavailability to bottom feeding biota, along with the effect of their source term on their distribution within the major sedimentary phases, the geochemical association of these longlived radionuclides has been evaluated.

In this study, two sections from Station 13 (50 m depth, 37°11.21 N 1°47.1 W) were selected: PASD13(01) corresponds to the first centimeter of the core; PASD13(09) is a deeper layer, and it corresponds to the 8-9 cm section. Station 13 is located south of the Almanzora river mouth in an area of the continental shelf where enhanced concentrations of transuranics have been previously found (GASCÓ *et al.*, 1992).

Chemical partioning of Pu and Am was performed by applying the following sequential leaching procedure: 12 g subsamples were stirred for 18 h with the appropriate amount of extractant, as shown in Table 1. The supernatant was filtered through a Whatman GF/C filter paper. Spikes of ^{242}Pu and ^{243} Am were added to determine the radiochemical yield of the procedure (COOK *et al.*, 1984).

Fraction	Reagant	Volume(ml/g)
Readily available	$CaCl_2$ 0.05 M	20
Exchangeable	CH_3-COOH 0.05 M	20
Organically bound	$Na_4P_2O_7$ 0.1 M	100
Oxide bound	$(NH_4CO_2)_2$0.175 M/$C_2O_4H_2$ 0.1 M	75
Residual	HNO_3/HF/HCl conc.	75

Table 1. Scheme of the leaching procedure for marine sediments

The results of chemical partitioning for Station 13 are summarized in Tables 2 and 3. The order of association of Pu in PASD13(01) is (Table 2): organic > oxide > residual > exchangeable > readily available. The fractions considered most mobile (readily available/exchangeable) contain less than 3% of the plutonium. The majority is associated with insoluble organic chelated complexes (66%).

The order of association of Am in PASD13(01) is (Table 2): exchangeable > organic > residual > oxide > readily available. Almost 50% of the Am is linked to the exchangeable phase, known as a "soluble" phase. Am also appears to be less associated with the sesquioxides (Al,Fe,Mn) than plutonium.

The isotopic ratios ^{238}Pu/^{239}Pu=0.04±0.01 and Am/Pu=0.3±0.1 indicate global fallout as the source term of these transuranics.

Fraction	^{239}Pu activ. Bq/kg d.w.	* ^{239}Pu content	^{241}Am activ. Bq/kg d.w.	% ^{241}Am content
Read. avail.	BDL	-----	BDL	-----
Exchangeable	0.06 ± 0.01	2.5 ± 0.4	0.24 ± 0.02	40. ± 6.1
Organ. bound	1.53 ± 0.10	66. ± 2.3	0.2 ± 0.01	33.3 ± 3.7
Oxide bound	0.51 ± 0.04	22. ± 1.7	0.05 ± 0.02	8.3 ± 4.1
Residual	0.22 ± 0.05	9.4 ± 2.0	0.10 ± 0.04	16.6 ± 7.9
Σ activity	2.3 ± 0.12		0.6 ± 0.05	

Table 2. Sequential leaching of PASD13(01). Uncertainties are given in ± 1σ.

Fraction	^{239}Pu activ. Bq/kg d.w.	* ^{239}Pu content	^{241}Am activ. Bq/kg d.w.	% ^{241}Am content
Read. avail.	0.01 ± 0.005	0.09 ± 0.05	BDL	-----
Exchangeable	0.15 ± 0.02	1.36 ± 0.21	0.51 ± 0.06	17.3 ± 0.04
Organ. bound	0.91 ± 0.06	8.23 ± 0.85	0.46 ± 0.10	15.6 ± 0.03
Oxide bound	0.80 ± 0.05	7.23 ± 0.71	0.05 ± 0.03	1.7 ± 0.003
Residual	9.19 ± 0.92	83.1 ± 1.52	1.93 ± 0.18	65.4 ± 0.14
Σ activity	11.06 ± 0.92		2.95 ± 0.22	

Table 3. Sequential leaching of PASD13(09). Uncertainties are given in ± 1σ.

The order of association for Pu is (Table 3): residual > organic > oxide > exchangeable > readily available. Most of the Pu appears in the residual fraction (88%), suggesting that the Pu is very refractory, like Pu in the aerosol dispersed during the accident in 1966. The order of association for Am is (Table 3): residual > exchangeable > organic > oxide > readily available. Most of the Am also appears in the residual fraction, however, almost 20% is in the exchangeable phase.

The isotopic ratios ^{238}Pu/^{239}Pu=0.02±0.005 and 241Am/239Pu=0.24±0.03 suggest weapon grade Pu ratios, indicating that the transuranics detected at this depth originate from the Palomares accident.

REFERENCES

COOK *et al.*, 1984. Geochemical association of Pu and γ-emitting radionuclides in Caithness soils and marine particulates. *J. Environ. Radioactivity*, 1: 119–131.

GASCÓ et al., 1992. Transuranics tranfer in a Spanish marine ecosystem. J. Radioanal. Nucl. Chem. Articles, Vol 156, 1: 151–163.

ROMERO *et al.*, 1992. New aspects on the transuranics tranfer in the Palomares marine environment. *J. Radioanal. Nucl. Chem.* Articles, Vol. 161, 2: 489–494.

CAESIUM INVENTORIES IN SEDIMENT CORES IN AREAS UNDER THE INFLUENCE OF THE PO RIVER (ITALY) AND THE RHONE RIVER (FRANCE)

M. ARNAUD[1], S. CHARMASSON[1], R. DELFANTI[2], C. PAPUCCI[2]

[1] Institut de Protection et de Sûreté Nucléaire, Marine Radioecology Laboratory, BP 330, 83507 La Seyne-sur-Mer cedex, France

[2] Ente per le Nuove technologie, l'Energia e l'Ambiente, Marine Environment Research center, PO box 316, 19100 La Spezia, Italy

The Po and the Rhône are two of the major rivers flowing into the Mediterranean sea. They both drain large basins, have annual liquid flows among the highest in the Mediterranean region (respectively 1500 and 1750 $m^3.sec^{-1}$) and carry a comparable amount of suspended solids (in the order of 10^7t.year^{-1}).

The Rhône is the river with the highest number of nuclear facilities along its banks : 6 nuclear power plants (NPP) with 17 reactors of different types and one fuel reprocessing plant in Marcoule. All these facilities are authorized to discharge low level radioactive liquid effluents into the aquatic environment after processing and compliance with the legislation in force. The outflow of the Rhône is transported by the prevailing currents mainly to the west during calm periods, and southwestward under Mistral conditions.

Along the Po river are located two NPP that were shut down in 1986. In addition being very far from the sea, they do not produce significant inputs of radionuclides into the Adriatic Sea. Water and suspended matter entering the Adriatic sea are dispersed mainly southward by the prevailing currents. Mud represents about 77% of the total particulate material.

In 1989-90 sampling campaigns were carried out in the marine areas under the influence of the Po and the Rhône rivers. Sediment cores have been collected in the areas of deposition of fine grained sediments, by using two types of box-corer, both with a large collecting area (300 and 730 cm^2), that allowed sediment cores of 30-40 cm long to be taken up. The cores were sectioned on board in 1 cm thick layers. The samples were dried, weighed and blended in the laboratory; ^{134}Cs and ^{137}Cs were determined by direct gamma spectrometry. From the vertical profiles of the two radionuclides, the inventories were determined from the sum of the total activity in each layer divided by the surface of the core. The results are reported on Fig. 1.

In the area under the influence of the Po river the inventories of ^{137}Cs ranged from 1.9 to 3.7 kBq.m^{-2}. In this area the contribution of Chernobyl ^{137}Cs, calculated from ^{134}Cs, was usually lower than 30%. In the sample collected in the prodelta area, southward and close to the Po river mouth, both concentration and inventory (more than 21.5 kBq.m^{-2}) were one order of magnitude higher, in relation to enhanced sedimentation regimes in this small, well protected area. In the Gulf of Lions, the ^{137}Cs inventories ranged from 1.2 to 6.9 kBq.m^{-2}. Again, in the prodelta, the concentration and inventory of ^{137}Cs (more than 26 kBq.m^{-2}) were much higher than in the surrounding area. Due to high sedimentation rates occurring near the Rhône mouth, ^{137}Cs inventories appear to be linked rather to recent inputs from the nuclear facilities than to the influence of the Chernobyl fallout and run off.

The studies carried out in both regions confirm that the greater part of suspended matter and the associated pollutants transported by the two rivers into the Mediterranean Sea are temporarily trapped in a small prodelta area, where the sedimentation processes are governed by electro-chemical flocculation and by particle aggregation phenomena. Off the prodelta areas, the inventories reflect what is known about the areas of influence of these two rivers.

Although the supply of suspended solids from the two rivers is very similar, the ^{137}Cs inventories found near the Po river mouth are about 40 % of those calculated for the area under the influence of the Rhône. These differences are certainly due, to some extent, to the input of radionuclides from nuclear facilities along the Rhône river. But, on the other hand, it must be considered that the North-Adriatic Sea is a shallow area, having no more than 40 m water depth and therefore, under the action of the strong winter winds, fine-grained sediments can easily be re-suspended from the bottom and transported elsewhere by the prevailing currents.

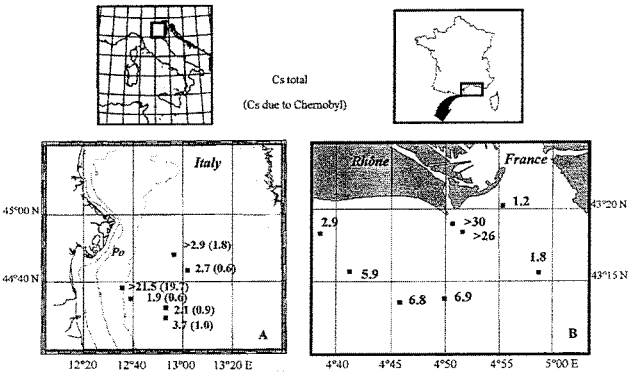


Figure 1: ^{137}Cs inventories (kBq.m^{-2}) in sediment near the mouth of the Po river (A) and the Rhône river (B). (> : core not sufficiently long to see termination of ^{137}Cs signal)

REFERENCES:

CALMET D., FERNANDEZ J.-M., 1990: Caesium distribution in northwest Mediterranean seawater, suspended particles and sediment. *Cont. Shelf Res.*, 110 : 895-913.

CHARMASSON S., ARNAUD M., BOUISSET P., 1994: Distribution of ^{137}Cs and ^{134}Cs in sediment near the mouth of the Rhône river (Gulf of Lions-Mediterranean sea). *In* Proceedings of the seminar on "The radiological exposure of the population of the european community from radioactivity in the Mediterranean sea", Rome 17-19 May, in press.

DELFANTI R., FIORE V., PAPUCCI C., LORENZELLI R., SALVI S., ALBONI M., MORETTI L., TESINI E., 1992 : Monitoraggio della radioattivita' ambientale nell'Adriatico centro-settentrionale, 1986-1991. *Societa' Italiana di Ecologia*, atti, 15 : 739-742.

FRIGNANI M., LANGONE L., 1992: Accumulation rates and ^{137}Cs distribution in sediments off the Po river delta and the Emilia-Romagna coast. *Cont. Shelf Res.*, 11 : 525-542.

R

21O PB, METAUX, CARBONE: INDICATEURS DES PROCESSUS DE FOCALISATION SUR LES MARGES CONTINENTALES

BERNAT M.[1], BUSCAIL R.[2], AMBATSIAN P.[1], MONACO A[2].

[1] Lab. de Géochimie Isotopique, URA 132, Fac. des Sciences, Nice. France.
[2] Lab. de Géochimie et Sédimentologie Marine, URA 715, Univ. de Perpignan, France.

Nous avons analysé des sédiments provenant de la marge du Golfe du Lion : pH, Eh, 21O Pb, C et Corg, formes "organiques" et "oxydées" de Mn. Les sédiments ont été prélevés par "box corer" ou submersible CYANA, ce qui a permis notamment de contrôler la préservation de l'interface. Ils proviennent d'un domaine bathymétrique compris entre 400 et 2300 m de profondeur, dans divers contextes morphologiques : canyons (R2P, B109, PRP7, KI05 et 26), interfluves (STl0, KI35, B12), delta profond (KI18 et 21, B9). Les analyses de Mn sont pratiquées sur la fraction < 40 mm. Nous avons utilisé l'attaque séquentielle à partir de 200 mg à 1 g de sédiment. H2O2 (FEELY *et al.* 1982, 1986) libère la phase associée à la matière organique (ORG). Elle est suivie par une réduction par l'hydroxylamine chlorhydrateen milieu acétique (CHESTER et HUGUES, 1967) qui extrait les éléments facilement échangeables, associés aux carbonates et aux oxydes (OX). C est analysé par combustion (Leco WR 12). Les isotopes de l'uranium et du thorium ont été analysés par spectrométrie alpha, 210 Pb par l'intermédiaire de son descendant émetteur beta 210 Bi.

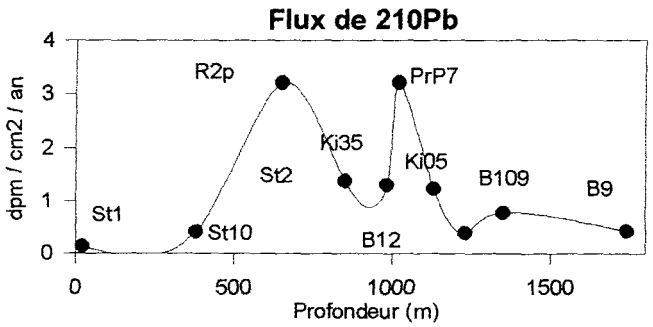
Résultats.

1- Le carbone organique. Jusqu'à 1 300 m sur la pente, l'épaisseur de vase oxydée varie entre 2 et 12 cm; pour les zones profondes (< 1 700 m) elle est d'environ 20 cm. Dans l'axe du canyon du Petit Rhône à 1875 m, pour 16% de Corg, elle est de 23 cm. Par contre, à 1 790 m, le chenal axial du canyon de Marseille se distingue par une épaisseur de vase oxydée faible (8 cm), une forte accumulation de Corg et une diminution de seulement 7% de entre la surface et l0 cm, par rapport aux autres canyons de profondeur comparable. Plus la couche de vase oxydée est épaisse, plus la proportion de Corg dégradée est importante (35%). Le coefficient de corrélation est de 0.8. L'épaisseur de vase oxydée augmente avec la profondeur (r = 0,6). De meilleures corrélations (r = 0,95) s'observent, lorsque l'on définit des classes physiographiques : axes et versants des canyons, interfluves. Entre le Corg et l'épaisseur oxydée, pour l'ensemble des sites, la relation est inverse (-0,6). Dans la zone des 1 000 m, Corg varie de 0,74 à 0,9%; jusqu'à 0,94% dans les canyons et 0,63 sur les interfluves.

2- Le manganèse. Sur les deux premiers cm de dépôt, les plus fortes concentrations en Mn se situent autour de 1 000 m de profondeur, au niveau de la pente continentale; la moyenne est de 64 µg/g pour MnOrg et de 1400 µg/g pour MnOx. Les plus faibles, sur la pente supérieure (-400 m), sont comparables à celles des sédiments de la plateforme continentale et de la pente inférieure (1 200 à 1 700 m) lorsque ceux-ci sont soumis à des phénomènes de remobilisation; elles sont alors en moyenne de 4 µg/g pourMnOrg et 495 µg/g pour MnOx. Sur le glacis et les sédiments profonds (canyons SW Lacaze-Duthiers et E Petit-Rhône), les concentrations atteignent 9,5 et 860 µg/g. A profondeur égale, le facteur morphologique joue un rôle important, les concentrations les plus fortes sont dans les aires en dépression; autour de 400 m, les concentrations sur la pente ouverte sont 4 contre 80 pour le MnOrg et 417 contre 882 pour le MnOx dans le canyon adjacent. Il en est de même pour des profondeurs plus importantes.

3- Le plomb 210. Dans cinq carottes sur dix, la décroissance de l'activité est régulière avec la profondeur, trois montrent des changements de sédimentation. Les vitesses de sédimentation (N = N0 e- t) de KI05 et KI35 sont de l'ordre de 140 cm/1000 ans, pour B109, R2P1 et PRP7, on trouve 180, 190 et 185 cm/1000 ans. En tenant compte des teneurs en eau et densités, on peut calculer les flux (Fig.) au dessus de chaque station (F = I, avec I concentration totale 210Pb dans le profil) : ST1, ST10,B12, B9 ont des flux inférieurs aux flux théoriques, pour KI05 (1,26-dpm/an), KI35 et ST2 (1,48 dpm/an) et B109 (1,04 dpm/an), ils sont un peu supérieurs; en revanche pour R2P1 (2,92 dpm/an) et PRP7 (2,96 dpm/an), ils sont trois fois plus élevés.

Les comportements de Corg, de Mn et de 210Pb montrent que sur la marge continentale existe une zone entre le plateau continental et le bassin, à l'aplomb de la pente et du courant liguro-provençal, où ces éléments se concentrent. Ce comportement est symptomatique du fonctionnement particulier de cette zone à l'échelle du siècle. Le processus de diagenèse précoce qui conduit à la minéralisation de la phase organique, à la diffusion du Mn vers l'interface oxydée et à sa précipitation s'installe en l'absence d'autres processus de perturbation. Dans le cas contraire, il y a absence ou destructuration du gradient diagénétique, notamment sur la pente supérieure et le delta profond.



REFERENCES

CHESTER R. and HUGUES M.J.,1967 -A chemical technic for the separation of ferro-manganese minerals, carbonate minerals and adsorbed trace elements from pelagic sediments. *Chem. Geol.*, Amsterdam, 2: 249-262.

FEELY R. A., MASSOTH G. J., BOKER E. T., GENDRON J. F., PAULSON A. J. and CRECELIUS E. A., 1986 - Seasonal and vertical variations in the elemental composition of suspended and settling particulate matter in Puget Sound,Washington. *Estuarine, Coastal and Shelf Science*, 22: 21S-239. FINP.

137CS MONITORING IN THE ROMANIAN SECTOR OF THE BLACK SEA

Alexandru S. BOLOGA[1], Iolanda OSVATH[2,3] and Constantin DOVLETE[2]

[1] Romanian Marine Research Institute, Constantza, Romania
[2] Environ. Radioactivity Lab., Inst. of Environ. Research and Engineering, Bucharest, Romania
[3] presently at IAEA Marine Environment Laboratory, Monaco

Natural and artificial radionuclides in the biotic and abiotic components of the Black Sea environment are being monitored within the framework of national and international programmes (BOLOGA, 1992; BOLOGA *et al.* 1994). The Romanian programme, results of which are given in this paper, aims :

- to monitor the space and time trends of radionuclide distribution in the marine environment,
- to increase knowledge of environmental distribution coefficients for marine sediment and concentration factors for the locally relevant species of marine biota,
- to produce an assessment of individual and collective doses to the Romanian population from radionuclides in the Black Sea, through internal and external exposure pathways.

Radionuclide concentration data obtained within this programme were included in the Romanian environmental radioactivity data base (OSVATH *et al.*, 1992), GIRMED (CIESM) and GLOMARD (IAEA) marine radioactivity data bases. A summary of ^{137}Cs data, based on samples analysed thus far, is presented here for the years 1986-1991. Samples were collected off the Romanian coast as follows :

- bottom sediment, surface and bottom sea water along profiles offshore the Danube mouths, at least twice a year,
- beach sediment, surface sea water and molluscs from nearshore and surface sea water along the Constantza profile, quarterly,
- macrophytes and fish, several times a month during April through September.

The samples were processed according to standard methodologies (BOLOGA *et al.*, 1991). High resolution, low background gamma spectrometric analyses were performed employing CANBERRA Quanta and Jupiter systems. From a greater number of samples collected and processed during the period 1986-1991, over 600 samples have been analysed to date.

During the interval between 1986 and 1991, ^{137}Cs levels in the northwestern Black Sea have decreased considerably (Fig.1), but have not reached the pre-Chernobyl values. A ^{137}Cs residence time of about 15 years can be estimated from a simple model. The relatively slow decrease of ^{137}Cs concentrations in bottom sediment as compared to sea water confirms the radionuclide retention ability of sediment. The evolution of ^{137}Cs concentrations in sea food following the major nuclear accident at the Chernobyl NPP in 1986, is an important component of the Romanian monitoring programme. From our data it can be concluded that ^{137}Cs concentrations in edible marine organisms have always remained below FAO "action levels" (FAO, 1986) in the study area, as illustrated in the case of fish (Fig.2). Similar trends were observed for molluscs and macrophytes.

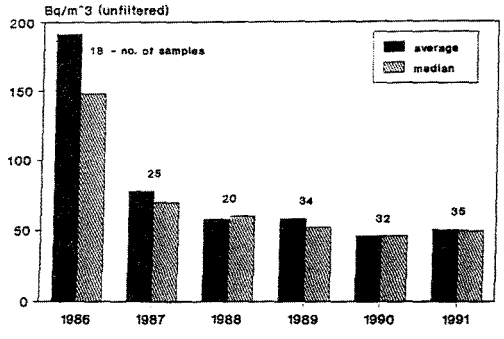


Fig.1. Cs-137 in NW Black Sea surface water

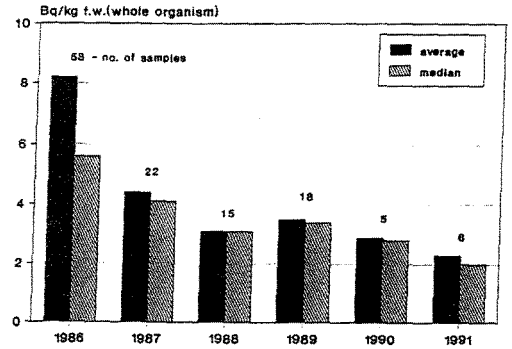


Fig.2. Cs-137 in fish from NW Black Sea

REFERENCES

BOLOGA A.S., 1992 - IAEA Research Contract No.4805/ROM/RB/1987-1992. Final Report, RMRI.

BOLOGA A.S., OSVATH I., PATRASCU V., 1994 - IAEA Co-ordinated Research Program "MARDOS"/ Research Agreement K4.10.03/1989-1992. Final Report, RMRI-IAEA MEL.

BOLOGA A.S., OSVATH I., DOVLETE C., 1994 - Proc. NATO/CCMS Meeting, Bucharest, March 1-2.

OSVATH I., DOVLETE C., BOLOGA A.S., 1992 - *Rapp. Comm. int. Mer Medit.*, 33 : 384.

BOLOGA A.S., OSVATH I., DOVLETE C., 1991 - *St. Cerc. Fiz.*, 43 : 1-2, 53-66.

FAO, 1986 - Report of the expert consultation on recommended limits for radionuclide contamination of foods. Rome, 1-5 December, ESN/MISC/87/1.

CHEMICAL AND RADIOCHEMICAL CHARACTERIZATION OF TOTAL ATMOSPHERIC DEPOSITIONS IN VENICE LAGOON

S. DEGETTO[1], G. SBRIGNADELLO[1], L. TOSITTI[2], O. TUBERTINI[2]

[1] Institute of Chemistry, Inorganic Technologies and Advanced Materials. C.N.R C.so Stati Uniti, 4. 35100 Padova, Italy

[2] Centre for Environ. Radiochemistry, Dept. of Chemistry, Univ. Bologna, Italy

Atmospheric depositions play a relevant role in the environmental cycling of chemical substances. Their contribution may be especially crucial in heavily industrialised areas, where stack and diffused emissions may distinctively contaminate the atmosphere with well-known environmental consequences. Among the possible effects, ^{210}Pb emitted from coal-fired power plants may significantly affect the natural atmospheric ^{210}Pb flux, therefore disturbing its use in radiochronological reconstruction of the sedimentary history of the local environment.

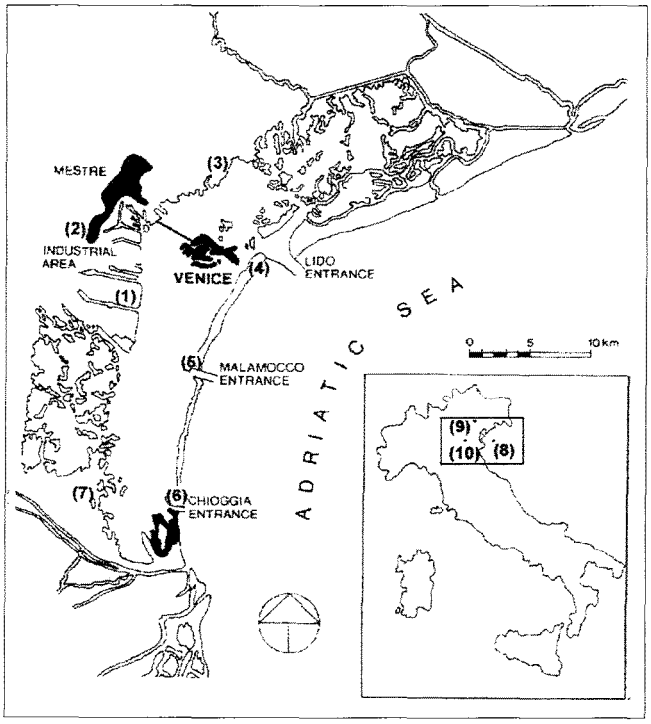
Since the use of the ^{210}Pb technique is of basic importance for the evaluation of the dynamic aspects of pollution, it follows that a detailed knowledge of all the atmospheric inputs, together with recent environmental modifications of the catchment area, are required for a correct model application.

In this work, chemical (main species and trace elements) and radiochemical data from total atmospheric depositions over the Venice Lagoon are presented. While the whole area is currently the subject of extensive and detailed investigations as regards the hydrological system and inflows, data concerning atmospheric inputs are still fairly limited, with the exception of the local air monitoring network which includes only classical gaseous pollutants.

Samples were collected at 7 stations within the lagoon area including the industrialised area and the major urban settlements of Venice, Mestre and Chioggia. In addition, samples from 3 other sites outside the lagoon area, but lying within approximately 20 km from the main town, were obtained for analysis. In Fig. 1, the study area and sampling stations are shown.

Mean annual fluxes, determined for the period April 1989 - March 1990, for some chemical and radiochemical species are reported in Table 1. The deposition of chemical species from the atmosphere appears to be mainly dominated by precipitation scavenging. Total N, P and S fluxes are representative of a typical heavily urbanized area; in particular, data from station (1) highlight the local effects of industrial activity. However the values observed for ^{210}Pb are in a range already observed at this latitude; this allows excluding, at least in first approximation, significant contributions from the large coal-fired power plant located near station (1).

Fig.1. Lagoon of Venice and sampling stations (1-10)



Tab.1 Total deposition observed in the Lagoon stations

	Station (1)	Stations (2-7)
Rain (mm)	621	498-637
Dry dep.(g m^{-2} yV)	82	11.3-18.3
Total N (g m^{-2} yV)	4.4	1.3-2.1
Total P (g m^{-2} y^{-1})	1.9	0.05-0.33
Total S as SO_2 (g m^{-2} y^{-1})	19	2.9-4.4

* *n.s.= unsupported ^{210}Pb*

INVENTORIES OF $^{239,240}Pu$ IN SLOPE AND DEEP-SEA SEDIMENTS FROM THE IONIAN SEA AND THE ALGERIAN BASIN

R. DELFANTI and C. PAPUCCI

ENEA - C.R.A.M., P.O. Box 316, 19100 La Spezia, Italy

While a good data set already exists on plutonium levels and inventories in Mediterranean shelf sediments, only few plutonium data are presently available for slope and deep-sea areas. For this reason, selected deep Mediterranean areas having different morphological and sedimentological characteristics were studied, and plutonium vertical profiles and inventories have been determined. In this paper we report the results obtained for the margin of the continental shelf, the slope and the bottom of the Taranto Valley, a deep submarine canyon in the Ionian Sea, and for an open-sea reference area in the Algerian Abyssal Plain.

The sediment cores were collected by a modified Reineck corer and sectioned onboard in slices 1 cm thick. $^{239,240}Pu$ was separated from the matrix by leaching, double anion exchange and electroplating, and measured by alpha spectrometry.

The inventories of $^{239,240}Pu$ in sediments of the Taranto Valley are shown in Fig.1. In general there was a decrease in Pu inventories along the canyon from the shelf to the slope and the deepest part of the canyon. In shelf and slope cores, plutonium was detectable down to depths of at least 30 cm which was the average length of the cores collected. The inventories ranged from 90 to >160 Bq/m^2 and, in all cases, were higher than the cumulative fallout deposition at these latitudes (81 Bq/m^2, PERKINS and THOMAS, 1980). For the two samples at 150 m and 450 m, only a lower limit of the inventory is reported (>120 and >160 Bq/m^2 respectively), because plutonium concentrations were still relatively high at the bottom of our cores. These results are in good agreement to those reported for the continental shelf of the Gulf of Taranto by TRIULZI *et al.* (1982).

In the sediments collected at the bottom of the canyon at depths of 1500 m and 2000 m, $^{239,240}Pu$ was only detectable in the first 15 cm. The inventories of $^{239,240}Pu$ (58 Bq/m^2 at 2000 and 45 Bq/m^2 at 1500 m) were about 50% of the cumulative fallout deposition.

To evaluate the influence of morphological and sedimentological factors on the transport of plutonium from the continental shelf to the deep sea, the results obtained for the Taranto Valley were compared to the inventory of $^{239,240}Pu$ in a sediment core collected in the Algerian Abyssal Plain, an area where only pelagic sedimentation is active. In the latter case, plutonium was only present in the first 4 cm of the core and its concentration decreased regularly from the surface to depth. The inventory was 3± 2 Bq/m^2 (4% of the cumulative fallout deposition), comparable to the values obtained for deep cores from oligotrophic Atlantic areas (BUFFONI *et al.*, 1992).

The inventories calculated for the deepest part of the Taranto Valley are almost twenty times higher than in the open Western Mediterranean as a consequence of several processes :

- productivity is very low in the open Mediterranean Sea, resulting in scarce export production and in a low probability of the particle-associated plutonium reaching the sea bottom. In contrast, the particle population increases considerably in areas close to land and river mouths thus producing an effective removal of plutonium from the water column;
- the continental shelf of the Gulf of Taranto is very narrow and the slope is indented by several small canyons, some of them corresponding to mouths of rivers. Under these conditions, the particulate material exported by rivers and the associated radionuclides may easily be transported to deeper areas preferentially through the small canyons;
- slumping processes and hydrodynamic conditions inside the canyons facilitate the resuspension of sediments, thus enhancing the scavenging of particle-associated radionuclides from the water column.

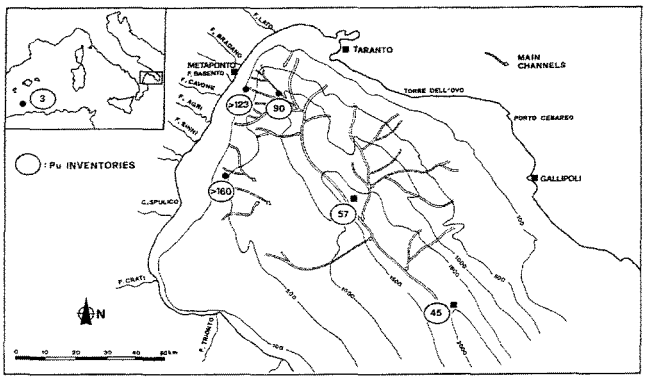


Fig. 1 - Inventories of $^{239,240}Pu$ (Bq/m^2) in sediments of the Gulf of Taranto (main figure) and in the Algerian Basin (upper left square).

AKNOWLEDGEMENTS

This work has been partially carried out under the European Commission - Radiation Protection Research Action Programme 1990-94 (Contracts Bi7-042 and F13P-CT92-0046). We wish to thank the Italian National Research Council (CNR) for having made available the R/V "URANIA" for the expeditions in the Gulf of Taranto and in the Western Mediterranean Sea.

REFERENCES

BUFFONI G., DELFANTI R., PAPUCCI C., 1992. Accumulation rates and mixing processes in near-surface North Atlantic sediments: evidence from 14C and $^{239,240}Pu$ down core profiles. *Marine Geology*, 109 :159-170.

PERKINS R.W. and C.W. THOMAS, 1980. Worldwide fallout. In: Transuranic Elements in the Environment, W.C. Hanson ed., U.S. Department of Energy/TIC-22800, Springfield, Virginia, USA, 53-82.

TRIULZI C., DELLE SITE A., MARCHIONNI V., 1982. $^{239,240}Pu$ and 238Pu in seawater, marine organisms and sediments of Taranto Gulf (Ionian Sea). *Estuarine, Coastal and Shelf Science*, 15 :109-114.

R

^{137}CS INVENTORIES IN THE WATER COLUMN AND IN SEDIMENTS OF THE WESTERN MEDITERRANEAN SEA

R.DELFANTI[1], C. PAPUCCI[1], M. ALBONI[2], R. LORENZELLI[2], S. SALVI[2]

[1] ENEA, C.R.A.M. S. Teresa, C.P. 316, 19100 La Spezia, Italy
[2] ENEA, C.R.E. Brasimone, C.P. 1, 40032 Camugnano (BO), Italy

With the aim of calculating the inventory of ^{137}Cs in the Mediterranean Sea, a study was carried out in the Western Mediterranean on present levels and inventories of this radionuclide in the water column and in sediments of the open sea environment. In recent years only few data have been published on the subject (CALMET and FERNANDEZ, 1990; IAEA MEL, 1991). Two sampling campaigns have been carried out in 1991 and 1992, collecting water and sediment samples, covering most of the Western Mediterranean basin. All the sampling stations were located in areas with water depth greater than 800 m. A Rosette sampler, equipped with a CTD probe and 12 X 30 litres Go-Flo bottles, was used to determine the hydrological characteristics of the water column and to collect water samples representative of the different W-Mediterranean water masses. Sediment samples were collected by a modified Reineck box-corer. The samples were sectioned onboard in layers 1 cm thick. ^{137}Cs was determined by γ-spectrometry: a) on 100 l of unfiltered seawater, after pre-concentration on AMP and b) on dried and blended sediments.

The vertical profiles of ^{137}Cs in the water column are shown in Fig.1. The concentration of ^{137}Cs in sea-water decreases from the surface to depth. A slight increase in ^{137}Cs concentration is observed near the bottom, likely due to resuspension of sediment from the sea-floor. The shape of these vertical profiles is very similar to that reported for the Western Mediterranean Sea in the pre-Chernobyl period (FUKAI *et al.*, 1980, BALLESTRA *et al.*, 1984), but in the 1991-92 samples a decrease in ^{137}Cs concentration in surface waters and an increase in the underlying water masses is observed. The inventories of ^{137}Cs in the water column (Fig.2) range from 2.2 to 6.8 kBq/m^2, in relation to water depth. However, the inventories of ^{137}Cs in the layer 0-600 m (corresponding to the layer Modified Atlantic Water + Levantine Intermediate Water) are rather homogeneous in the Western Mediterranean, with a mean value of 1.7±0.3 kBq/m^2.

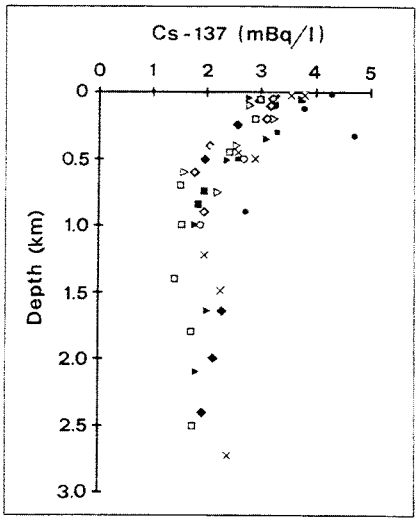


Fig.1 - Vertical profiles of ^{137}Cs in the water column.

The inventories in the Western Mediterranean Deep Water (layer 600 m to bottom) are proportional to the depth of the water column, ranging from 0.7 kBq/m^2 at 830 m to 4.8 kBq/m^2 at 2770 m. ^{137}Cs in sediments has been presently measured at two stations, the first one located SW of Sardinia and the second one in the channel between Ibiza and the Spanish coast, at water depths of 1025 m and 828 m, respectively. ^{137}Cs is only detectable in the first 10 cm. Its concentration decreases regularly from a surface value of 6 - 7 Bq/kg. The inventories of ^{137}Cs are very similar at these two sites (233 and 228 Bq/m^2), and correspond to about 5% of the cumulative fallout deposition at the latitude of the Mediterranean and to about 6-9% of the total inventory at these stations.

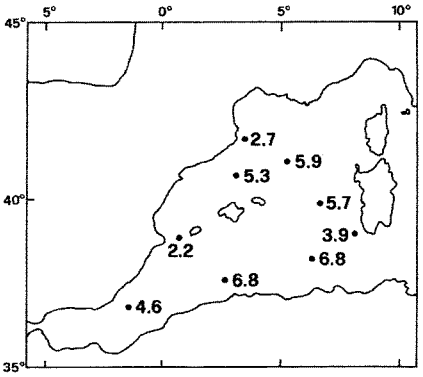


Fig.2 - Inventories of ^{137}Cs (kBq/m^2) in the water column

AKNOWLEDGEMENTS.
This work has been partially carried out under the European Commission - Radiation Protection Research Action Programme 1990-94 (Contracts Bi7-042 and F13P-CT92-0046). We also wish to thank the Italian National Research Council (CNR) for having made available the R/V "URANIA" for the expeditions in the Western Mediterranean Sea.

REFERENCES

FUKAI R., BALLESTRA S. and VAS D., 1980. Distribution of ^{137}Cs in the Mediterranean Sea', in: Management of the environment, Wiley Eastern Ltd., New Delhi-Bombay, 353-360.
BALLESTRA S., BOJANOWSKI R., FUKAI R. and VAS D., 1984. Behaviour of selected radionuclides in the Northwestern Mediterranean basin influenced by river discharge. In: International symposium on the behaviour of long-lived radionuclides in the marine environment, Cigna and Myttenaere eds. EUR 9214, CEC, Luxembourg, 215-232.
CALMET D. and FERNANDEZ J.M., 1990. Caesium distribution in northwest Mediterranean seawater, suspended particles and sediments. *Cont. Shelf. Res.*, 10 : 895-914.
IAEA MEL, 1991, International Marine Environment Laboratory - Monaco, Biennial report 1989-1990, IAEA Vienna, 81 pp.

BIOACCUMULATION AND RETENTION OF RADIONUCLIDES IN MARINE BIVALVES

Nicolas S. FISHER

Marine Sciences Research Center, State University of New York, Stony Brook, New York, USA.

A series of laboratory radiotracer experiments has been conducted in which the accumulation and retention of radioisotopes are quantified for marine mussels (*Mytilus edulis*), marine clams (*Macoma balthica, Mercenaria mercenaria*) and oysters (*Crassostrea virginica*).^{110}AG, ^{241}AM, ^{109}Cd, ^{14}C, ^{57}Co, ^{51}Cr, ^{210}Pb, ^{75}Se and ^{65}Zn were examined. For each animal species and radioisotope, the relative contributions of dissolved and particulate sources are quantified. To determine the importance of the particulate (i.e., food) source term, the assimilation efficiencies of ingested radioisotopes were determined for up seven different food types (the diatoms *Thalassiosira pseudonana* and *Phaeodactylum tricornutum*, the chlorophytes *Chlorella autotrophica* and *Nannochloris atomus*, the dinoflagellates *Prorocentrum minimum* and *Alexandrium tamarense*, the prasinophyte *Tetraselmis levis*, and the prymnesiophyte *Isochrysis galbana*). The effects of food quantity and temperature on assimilation efficiencies were also determined. Studies investigating the bioaccumulation of radioisotopes from the dissolved phase measured the effects of salinity and dissolved organic carbon on the bioavailability of the radioisotopes to the animals.

Overall conclusions includes the following : (1) assimilation efficiencies in bivalves for ingested radionuclides ranged from nearly zzero for ^{241}AM to over 90% for ^{75}Se; (2) metal assimilation was related to ingestion rate which is dependent on food quantity, with assimilation efficiencies decreasing inversely with algla food densities; (3) metal assimilation varied between food sources and was related to the distribution of the metals in the algal cells, with the cytosol fraction being most assimilable; this is similar to earlier findings with marine copepods and bivalve larvae (REINFELDER and FISHER, 1991, 1994); (4) assimilation of essential elements (e.g., Se, Zn) was related to carbon assimilation; (5) for most radioisotopes, increasing salinity had a small dampening effect on metal accumulation rates from the dissolved phase; (6) oysters retained certain metals (especially ^{110}AG and ^{65}Zn) much longer than did clams and mussels, perhaps explaining the very high concentrations of these metals in oysters in nature (NOAA, 1989); (7) the distribution of radionuclides in the bivalves was strongly dependent on the dominant source term, with most dissolved radioisotope localizing in shell and most ingested radioisotope in soft parts (particularly viscera),as noted in earlier studies (e.g., BJERREGAARD *et al.*, 1985; FISHER and TEYSSIE, 1986); (8) those elements which display low assimilation efficiencies in the bivalves are probably accumulated in these animals predominantly from the dissolved phase, whereas elements with high assimilation efficiencies are probably obtained primarily through trophic transfer, consistent with earlier conclusions of earlier work (LUOMA *et al.*,1992). The results are being used to develop both equilibrium and kinetic models of radioisotope accumulation in marine bivalves, which are being tested in bivalve field transplant experiments.

REFERENCES

BJERREGAARD P., TOPÇUOGLU S., FISHER N. S. and FOWLER S.W. 1985.Biokinetics of americium and plutonium in the mussel *Mytilus edulis*. *Mar. Ecol. Prog. Ser.* 21 : 99-111.
FISHER N. S. and TEYSSIE J.-L. 1986 Influence of food composition on the biokinetics and tissue distribution of zinc and americium in mussels. *Mar. Ecol. Prog. Ser.* 28 : 197-207.
LUOMA S. N., JOHNS C., FISHER N. S., STEINBERG N. A., OREMLAND R. S. and REINFELDER J. R. 1992. Determination of selenium bioavailability to a benthic bivalve from particulate and solute pathways. *Envir. Sci. Technol.* 26 : 485-491.
NOAA. 1989. A summary of data on tissue contamination from the first three years (1986-1988) of the Mussel Watch Project. Tech. Mem. NOS OMA 49.
REINFELDER J. R. and FISHER N. S. 1991. The assimilation of elements ingested by marine copepods. *Science* 251 : 794-796.
REINFELDER J. R. and FISHER N. S. 1991. The assimilation of elements ingested by marine planktonic bivalve larvae. *Limnol. Oceanogr.* 39 : 12-20.

^{137}CS AS A TOOL FOR INVESTIGATING THE MIGRATION OF POLLUTANTS VIA WATER MASS MOVEMENT BETWEEN TWO DIFFERENT BASINS

H. FLOROU and P. KRITIDIS

N.C.S.R."Demokritos" 15310 Aghia Paraskevi, Athens, Greece

The northeastern Aegean Sea is an area where the Black Sea (B.S.) water mass interacts with Aegean Sea waters through the Dardanelles (Fig. 1). As the B.S. waters enter the Aegean Sea (A.S.), they are diluted in the northern and the western part of the A.S. The upper layer of the B.S. water mass is characterized by low salinitiy values, which produce high stability of buoyancy conditions. Thus, the upper layer (0 50 m) of the entire water column comes out to the A.S. through the Dardanelles, a narrow channel of 90 m maximum depth (NITTIS *et al.*,1990).

The situation outside of the mouth of Dardanelles in the A.S. is completely different, characterized by higher salinity values, deeper depths and strong currents during the cold period. The volume of water coming from B.S. is insignificant (300-700 km^3 annually) as compared with the total water volume of the eastern A.S. (90000 km^3)° however, the upper layer of the northern and western part of the A.S. is greatly affected by the B.S. water flux (Fig. 1).

The Chernobyl nuclear accident on 26 April 1986 resulted in a deposition of about 530 TBq of ^{137}Cs in the A.S. (KRITIDIS and FLOROU, 1990). The respective amount for the B.S. is about 2400 TBq. Since ^{137}Cs is re-suspended from the B.S. sediments and the river outflows deliver contaminated terrestrial material to the B.S., an amount of about 250 TBq is estimated to remain in the 0-50 m water layer based on data for the period 1986-1991 (EGOROV *et al.*, 1994). This amount is expected to be discharged from the B.S. into the Sea of Marmara and consequently to the northeastern A.S. through the Dardanelles channel.

According to our ^{137}Cs measurements of surface sea water during 1993, it was shown that approximately 48 TBq of ^{137}Cs was the 1993 discharge to the A.S. due to the purification process of the B.S. (FLOROU and KRITIDIS, 1994). Thus, we assume that the mouth of Dardanelles is a definite "point source of pollution" for the eastern Mediterranean with a more or less predictable amount of ^{137}Cs discharge. Considering the generic inventory of ^{137}Cs in the A.S. during 1993, the average concentration of ^{137}Cs in the mouth of Dardanelles close to the A.S. is 118 ± 8 Bq m^{-3}, whereas the mean estimated value for the A.S. is 20.7 ± 14.7 Bq m^{-3} (FLOROU *et al.*, 1994). This value is quite high if compared with the pre-accident levels (2.6 ± 0.3 Bq m^{-3} for the period 1984-85 reported by FLOROU (1992), or with the respective value for the Ionian Sea, 9.2 ± 2.5 Bq m^{-3} (FLOROU, 1994). If we look at the dispersion of ^{137}Cs, we note that this can reflect the surface current circulation pattern in this area, since the B.S. waters may be traced periodically from north to south in the A.S. region (Fig. 1).

The above considerations are being studied further and a model of ^{137}Cs dispersion based on meteorological and oceanographic data is now under evaluation. Since ^{137}Cs is a soluble tracer with a slow removal time from the water column, it could be used for the prediction not only of the dispersion of radioactive substances, but also of conventional pollutants.

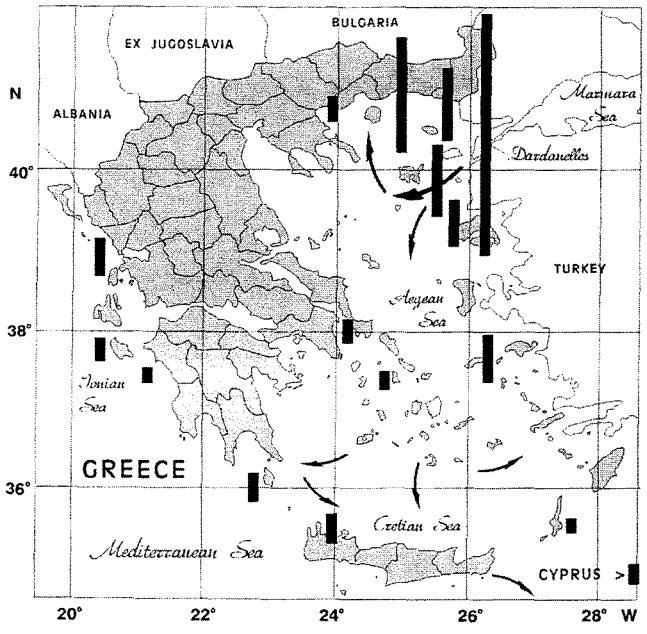


Fig. 1 : Concentrations of ^{137}CS and main directions of surface currents in the Aegean Sea (Florou and Kritidis, 1994; Zodiatis, 1993)

REFERENCES

EGOROV V.N., POLIKARPOV G.G., STOKOZOV N.A., KULEBAKINA L.G., LAZORENKO L.G., 1994. Proc. MARINA-MED Seminar, Rome 17-19 May 1994 (in press).

FLOROU H., 1992. Ph.D. Thesis, University of Athens 1992, 253 p.

FLOROU H., 1994. p.p.117-121 in: Report by a Group of Experts Convened by the European Commission, XI-094/93 (Cigna A. ed.) 234 p.

FLOROU H., HALOULOU Ch., TRABIDOU Z., ZAPHYROPOULOU A., LIKOMITROU Ch., MICHALEAS S., 1994. Seminar on the Radiological Exposure of the Population of the E.C. from Radioactivity in the Mediterranean Sea, Rome, 17-19 May 1994 (in press).

FLOROU H. and KRITIDIS P., 1994, *Radiochimica Acta.*

KRITIDIS P. and FLOROU E., 1990, *Rapp. Comm. int. Mer Medit.*, 32,1 : 318.

NITTIS K., THEOCHARIS A. and LASKARATOS A., 1990. *Rapp. Comm. int. Mer Medit.*, 32, 1 : 161.

ZODIATIS G., 1993. Proc. 4rth Panhellenic Symposium on Oceanography and Fishery, April 22-29, 1993, p. 43-46

ASSIMILATION AND RETENTION OF HEAVY METALS AND RADIONUCLIDES IN SEASTARS

Scott W. FOWLER and Jean-Louis TEYSSIE

IAEA Marine Environment Laboratory, P.O. Box 800, MC 98012 Monaco

From both ecological and toxicological viewpoints, it is important to understand the transfer and cycling of trace elements and contaminant heavy metals and radionuclides through marine food chains. Studying these aspects in the natural system or using elevated concentrations of the target elements under simulated conditions usually entails greatly perturbing the elemental composition of the water, subsampling from a large population of organisms, and carrying out lengthy chemical separations for eventual elemental and/or radionuclide analyses. The use of high specific activity or carrier-free gamma-emitting radiotracers of these elements circumvents these problems and allows rapid radioanalyses of live organisms or tissues which have been exposed to the contaminants at concentrations more likely to be present in the surrounding waters.

For our studies, we have developed a multi-isotope analytical technique which allows measuring simultaneously seven gamma-emitting radiotracers in the same experimental organisms. Use of this multi-tracer technique reduces inter-experimental variation which occurs between separate treatments labelled with single radioisotopes. This report summarizes results from laboratory radiotracer experiments aimed at quantifying the assimilation and retention of some key heavy metals and radionuclides in carnivorous seastars following contaminant transfer via a typical three-step food chain (phytoplankton - bivalve - seastar).

Carrier-free or high specific activity solutions of the gamma emitters ^{109}Cd, ^{65}Zn, ^{110m}Ag, ^{60}Co (inorganic) and ^{57}Co (cobalamine) were employed in all experiments. In addition, two radionuclides of current interest, ^{241}Am and ^{134}Cs, were also used in the multi-isotope mixture. Mussels (*Mytilus edulis*) were labelled for 96 hours in sea water containing a suspension of phytoplankton cells (*Isochrysis galbana*, 5x10^3 cells/ml) and radiotracers of the selected elements. During this period, the labelling medium was changed every 24 hours. Following the contamination period, the mussels were rinsed and their soft parts removed and counted for radionuclide content. The mussel soft parts were then fed to asteroids (*Marthasterias glacialis*) which promptly ingested the food ration. After radio-labelled feeding, the seastars were periodically whole body counted live over the next several weeks in order to assess excretion rates for the different elements. General experimental protocols, radio-labelling techniques and whole body gamma spectrometric analyses (GeLi detector) of the radiotracers in marine organisms are described elsewhere (GUARY *et al.*, 1982; FISHER *et al.*, 1991; NOLAN *et al.*, 1992).

Assimilation efficiencies of all the elements tested were very high often ranging between 60 and 100% retention of the ingested dose several days after feeding. This was particularly evident for the organic form of cobalt of which 80-100% was retained by the asteroids during the first month of the excretion period. At different times during the experiment, mean percent activity retained was calculated for each radionuclide using 3 to 5 individual seastars, and the resultant excretion patterns examined. In all cases, it appeared that excretion kinetics could be fit to a single exponential model. Therefore, as a first estimation of excretion rates linear regression analysis was applied to the loss curves which extended over a period of nearly 4.5 months. Biological half-lives for radiotracer loss are given in Table 1. In all cases the computed half-times were relatively long ranging from approximately 4 to 100 days. Of particular interest is the long biological half-life of zinc, a biologically essential element active in co-enzyme systems. Although measurements were made for several months, there was some indication toward the end of the experiment that certain elements (e.g. Co org., Zn and Ag) were entering into a much slower loss phase.

Element/ RN	Ag	Cd	Co(in.)	Co(org.)	Zn	^{134,137}C s	^{241}Am
Tb½ (days)	57	47	40	53	101	78	44

Table 1. Biological half-lives (Tb1/2) of selected elements and radionuclides in the seastar *Marthasterias glacialis* following a single ingestion of radiolabelled food.

Other noteworthy features were the enhanced retention of organic Co over the inorganic form (Fig. 1) and the stronger retention of the monovalent radiocaesium compared to trivalent ^{241}Am. This latter observation merits further investigation particularly in view of the many studies which report longer biological half-lives for ^{241}Am than radiocaesium in marine organisms.

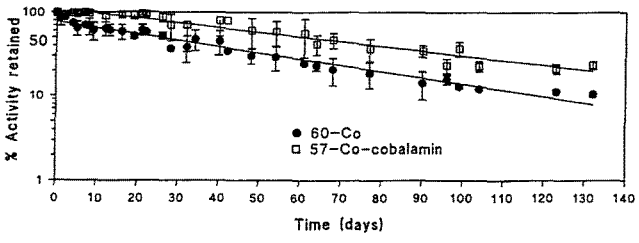


Fig. 1.Long-term excretion of inorganic ^{60}Co and ^{57}Co-cobalamine in seastars following a single ingestion of radiolabelled food. T = 15±1°C; S = 37‰; Bars =±1σ.

REFERENCES

FISHER N. S., NOLAN C. V. and FOWLER S. W., 1991. Assimilation of metals in marine copepods and its biogeochemical implications. *Mar. Ecol. Prog. Ser.* 71: 37-43.

GUARY,J.-C., FOWLER S.W. and BEASLEY T.M., 1982. Routes of plutonium uptake and their relation to biomagnification in starfish. *Mar.Pollut. Bull.* 13 : 99-102.

NOLAN C. V., FOWLER S. W. and TEYSSIE J.-L., 1992. Cobalt speciation and bioavailibility in marine organisms. *Mar. Ecol. Prog. Ser.* 88 : 105-116.

R

TRITIUM IN THE EASTERN MEDITERRANEAN SEA

J.R. GAT, A. SHEMESH and I. CARMI

Department of Environmental Sciences and Energy Research
Weizmann Institute of Science, Rehovot, Israel

A hydrographic survey conducted in the eastern Mediterranean within the framework of the POEM program during 1988/89 included the measurement of tritium in the water samples. Surface concentrations of tritium have decreased considerably relative to 1968, when values ranged up to 30 TU (ASSAF, 1968). Surface tritium values during the present survey were close to 5 TU near the Turkish coast and were even lower in the southern part of the eastern basin, ranging from 2.7-3.7 TU (Fig. 1). In the north-eastern part of the basin values of 3-5 TU persisted to a depth of 300-500 meters. In the central part of the basin, around Crete, such high tritium levels were encountered at much greater depths, down to 1000-1500 meters. A well defined step structure of the vertical profile was noted at the more southerly stations, with intermediate values of around 2 TU at a depth of 300-600 meters. Furthermore, we observed a deepening of this step-layer from east to west (from 300-400 meters at Station 9 to 400-600 meters at Stations 14 and 10).

There is little correlation between tritium values and parameters such as d18O, temperature and salinity (GAT *et al.*, 1994), indicating that it is not simply local vertical mixing which results in penetration of tritium to deeper layers. The intermediate "step" in the tritium profiles is probably related to the Levantine Intermediate Waters (LIW) which originate in the eastern part of the basin. The relatively high tritium levels found down to the deeper waters in the area near Crete, may be indicative of the process of deep water formation at this site (ROETHER and SCHLITZER, 1991).

The tritium data in this period of declining atmospheric tritium levels have been found useful in delineating water masses and suggesting genetic relationships among them. The simultaneous measurement of helium-3 (^{3}He) and of tritium (^{3}H), which provides a time of closure (age) for the waters, is planned for the upcoming phase of the POEM program in December 1994. This can be expected to clarify the relationships between the different water bodies which were delineated in the eastern Mediterranean water column.

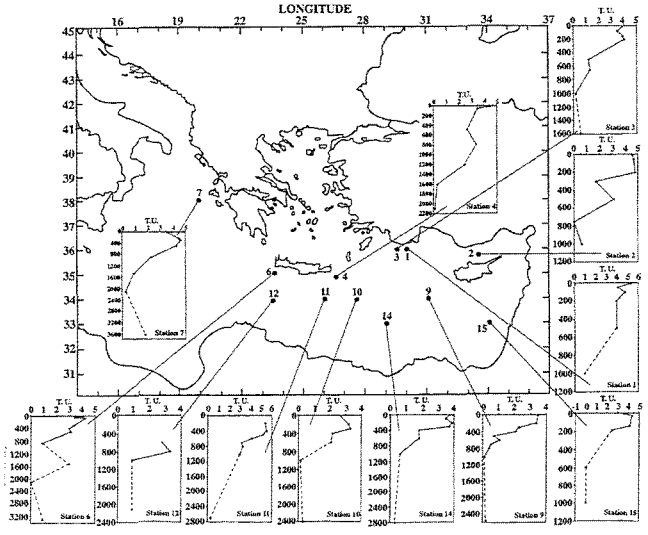


Fig. 1. Sampling stations in the Eastern Mediterranean and their vertical tritium profiles. Tritium concentrations are in tritium units (TU). Stations 1, 2 were sampled in July '88, stations 3,4,6 and 7 in September '88 and stations 9, 10,11,12, 14 and 15 in March '89.

REFERENCES

ASSAF, G., 1968. reported in Anati, D.A. and J.R. Gat, "Restricted Marine Basins and Marginal Sea Environments" In: *Handbook of Environmental Isotope Geochemistry* (Fritz, & Fontes, Editors) Elsevier, Vol. 3: 29-73, 1989.

GAT, J.R., A. SHEMESH, E. TZIPERMAN, A. HECHT, G. GEORGOPOLULIS and O. BASTURK, 1994. The stable isotope composition of waters of the Eastern Mediterranean Sea, *Tellus*, in press.

ROETHER, W. and R. SCHLITZER, 1991. Eastern Mediterranean deep water renewal on the basis of chlorofluoromethane and tritium data. *Dynamics of Atmospheres and Oceans*, 15: 333-354.

^{137}CS CONCENTRATION IN BED LOAD SEDIMENTS FROM THE DANUBE RIVER AND THE BLACK SEA DURING 1993

Iulia I. GEORGESCU[1], Gheorghe BARAN[1], Ana PANTELICA[2], Maria SALAGEAN[2]

[1] University Politehnic, Fac. Chem. Techn. Bucharest, Romania
[2] Institute of Physics and Nuclear Engineering, MG-6, Bucharest, Romania

In a previous study mathematical modelling of man-made radionuclides transfered and transported in the Danube river was undertaken by GEORGESCU (1986). This paper presents data on the variability of ^{137} Cs transported by the bed load sediments of the Danube river, Danube Delta and the Black Sea during 1993.

Sampling of the bed load sediments was performed simultaneously with hydrological and solid discharge measurements made during specific hydrological periods, i.e. during spring, summer and autumn at high and relatively low flow rates in the following cross-sections: Svinitza, Orsova, before the Turnu-Severin dam, Bechet (in front of the Kozlodui Nuclear Power Plant), Giurgiu, Ceatal-Izmail (beginning of the Danube Delta), Chilia and Sulina (Danube Delta) and Portitza and East Constantza in the Black Sea. About 2 kg of each sediment sample were dried in an electric oven at 105°C, homogenized and analyzed by gamma spectrometry with a HPGe detector for 18-20 h.

The ^{137}Cs activity in the sediments sampled is presented in Table 1. Concerning the presence of ^{134}Cs, it was only identified at locations with higher ^{137} Cs activities, e.g. up to 24±1 Bq/kg ^{134}Cs at Sulina.

Table 1. Contamination by ^{137}Cs of bed load sediments from the Danube river, Danube Delta and Black Sea during 1993.

Location and date of sampling		Activity Bq/kg (dry)	Location and date of sampling		Activity Bq/kg (dry)
Svinitza	8.04	114 ± 3	Ceatal-Izmail	24.04	1.6 ± 0.5
	8.08	107 ± 5		30.08	13.5 ± 1.9
Orsova	8.04	81 ± 2	Chilia km. 3	5.09	9.6 ± 0.8
	18.08	193 ± 10			
Turnu-Severin	9.05	3.4 ± 0.5	Sulina*	16.07	17.0 ± 0.7
	19.08	< 0.6	Sulina**	30.05	171 ± 5
Bechet km. 705	17.04	4.8 ± 0.4	Portitza	18.04	50 ± 2
	31.08	3.1 ± 0.3		19.07	22.4 ± 0.7
Bechet km. 678	17.04	2.8 ± 0.3	East Constantza	5.06	125 ± 6
	21.08	2.0 ± 0.5		13.07	253 ± 5
Giurgiu	13.04	2.1 ± 0.3			
	23.08	1.0 ± 0.2			

*) 2.5 nautical miles from Sulina **) 26 m depth in the Black Sea in front of Sulina Port.

With respect to the ^{137}Cs radioactivity levels, the Danube river and Black Sea coast can be divided into the following zones: Svinitza-Orsova (1st zone), Turnu-Severin dam - Ceatal-Izmail (2nd zone), Danube Delta (3rd zone) and Black Sea (4th zone). The lowest and nearly constant values were observed in the second zone where there are no important pollution sources of ^{137}Cs.

In the first zone which includes the entrace of the Danube into Romania, ^{137}Cs activities are about 50-100 times higher than those observed in the second zone. The highest ^{137}Cs activities were measured at the mouth of Danube river (Sulina) as well as south of the Danube Delta at Portitza and Constantza on the Black Sea. This may be explained by contaminated waters being transported in a southerly direction by the northeast marine currents.

To calculate radionuclide transport by the bed load sediments between two time intervals, the following relation has been used :

$$C_1 = Q_b^i \cdot C_b^i, \quad i = 1,2 \text{ (time periods)} \qquad (1)$$

$$C = \frac{C_1 + C_2}{2} \cdot \Delta t \qquad (2)$$

where Q_b is solid discharge (kg/s) C_b is activity (Bq/kg) and Δt is the time interval between the two measurements. For example, at the Giurgu cross section with Q_b^1 = 18,4 kg/s, Q_b^2 = 10 kg/s, C_b^1 = 2,1 Bq/kg, C_b^2 = 1,0 Bq/kg (see table 1), the total transported ^{137}Cs activity, during 132 days is 2,7 x 10^8 Bq.

Spatial and temporal variation of the natural radioactive series U-Ra and Th will be the subject of a separate paper (GEORGESCU, in prep.).

ACKNOWLEDGEMENTS.
The authors are indebted to Dr.C.BONDAR of the Institute of Meteorology and Hydrology, Bucharest, who furnished the samples and the corresponding hydrological data.

REFERENCES

GEORGESCU I.I., (1986), Chief Sci.Investing.: 1982-1986 - "Research Contract RB/3260: The mathematical modelling of man-made radionuclides transfered and transported on the Danube River under nuclear accident conditions", IAEA-Viena, 1982-1986.

R

CS-137 DISTRIBUTION IN LAGOON ENVIRONMENT OF NORTHERN ADRIATIC AFTER CHERNOBYL ACCIDENT

C. GIOVANI, R. PADOVANI[1],
G. MATTASSI[2], A. ZANELLO[2], C. ZANATA[2], L. ZANATA[2]
[1] Servizio di Fisica Sanitaria, USL 7, Udine, Italy
[2] Servizio di Igiene ambientale, USL 8, Palmanova, Italy

In 1991 the authors undertook a long-term program for monitoring environmental radioactivity in the Northern Adriatic, in order to evaluate the post-Chernobyl diffusion of artificial radionuclides in areas close to coasts and lagoons between Grado and Punta Tagliamento. This program involves periodic sampling of surface sediments and algae taken during different seasons. The main aims of this study were: 1) measurement of the post-Chernobyl radiocaesium distribution in the lagoon and coastal environment of the region Friuli-Venezia Giulia; 2) evaluation of the grain-size distribution effect on radiocaesium absorption in sediments; 3) the correlation of radiocaesium distribution between sediments and algae.

The first results of this work, which derive from the analysis of the Cs-137 concentration in sediment samples collected in 1991 (GIOVANI *et al.*, 1992; GIOVANI *et al.*, 1994a), allowed us to discern four different areas in the selected environment: 1) river mouth with the highest detected values; 2) lagoons; 3) marine area close to lagoon inlets with the lowest concentrations; 4) external marine area also with high values.

Figure 1 shows the distribution of Cs-137 concentrations in surface sediments in 1992. In this case it is also possible to delineate the same areas that have been previously identified. Samples collected along the Cormor river and in front of one portion of Marano lagoon during 1992 give further information about the radiocaesium distribution in this type of environment. The river samples are the most contaminated of all, while those samples collected far from the coast show low Cs-137 activities.

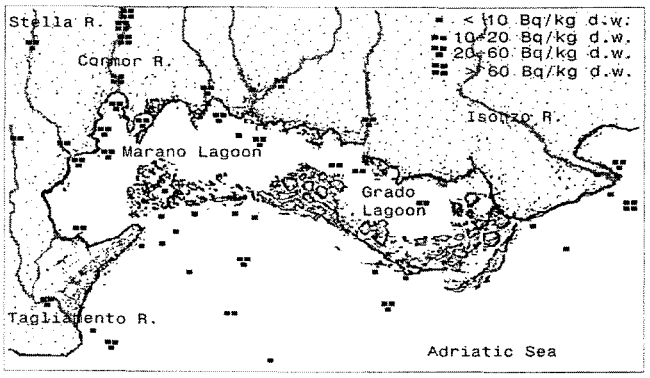


Figure 1. Cs-137 distribution in sediments (Bq/kg d.w.) in November 1992.

Cs-137 concentrations in surface sediments collected in 1991, 1992 and 1993 versus the silt-clay fraction percentage (diameter > 63 µm) are shown in Fig.2. It is noted that where the silt-clay fraction percentage is high, the concentration is also high. In order to investigate the correlation between algae and the sediment Cs-137 content, the genus *Ulva* was chosen because of its abundance in the sampling area. Cs-137 concentration in *Ulva* samples and Cs-137 in sediments in 1991 showed a significantly positive correlation (r = 0.880; p < 0.1 %) (GIOVANI *et al.*, 1994b).

The significance of the correlation between Cs-137 content in algae and in sediments confirms the role of this kind of organism as a biological indicator of radiocontamination as well as for conventional pollutants.

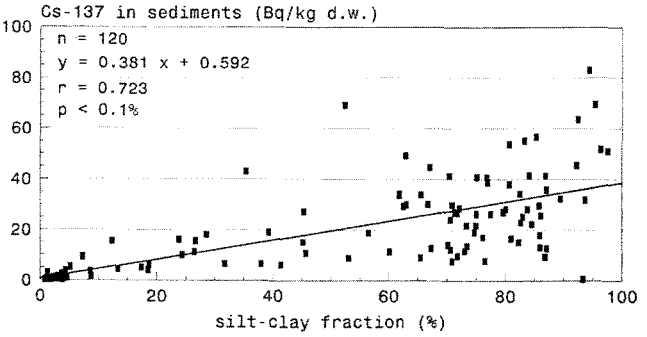


Figure 2. Cs-137 concentration vs grain-size in sediments of 1991, 1992 and 1993 samplings. (% of the fraction > 63 µm).

REFERENCES

GIOVANI C., DARIS F., MATTASSI G., PADOVANI R., ZANELLO A., 1992. Cs-137 and I-131 Distribution in Lagoonal and Coastal Environment in Northern Adriatic - Rapp.Comm.Int Mer Medit, 33:337

GIOVANI C., GODEASSI M., MATTASSI G., PADOVANI R., ZANELLO A., 1994a. Cs-137 Distribution in Sediments of Grado and Marano Lagoons (Northern Adriatic) - paper presented at the Seminar on The Radiological Exposure of the Population of the European Community from Radioactivity in the Mediterranean Sea, Rome, 17-19 May, in press

GIOVANI C., MATTASSI G., PADOVANI R., ZANELLO A., ZANINI S., 1994b. Distribution of Artificial Radiocontamination in Lagoon Environment of Northern Adriatic - paper presented at the International Seminar on Freshwater and Estuarine Radioecology, Lisbon, 21-25 March 1994, in press.

ENVIRONMENTAL LEVELS OF AMERICIUM-241 IN TWO MEDITERRANEAN SEASTARS

Jean-Claude GUARY[1], Scott W. FOWLER[2] and Thomas M. BEASLEY[3]
[1] Institut Nal des Sciences et Techniques de la Mer, B.P. 324, Cherbourg, France
[2]IAEA Marine Environment Laboratory, P.O. Box 800, MC-98012, Monaco
[3] Dept of Energy, Environ. Measurements Lab., 376 Hudson Str., NewYork 10014-3621, USA

Previous works (GUARY, 1980) have clearly shown that the tissue distribution of ^{241}Am in seastars is strongly dependent on the uptake pathway. As was the case for plutonium (GUARY *et al.*, 1982), it is of interest to examine the distribution of fallout ^{241}Am in Mediterranean seastars in order to define the accumulation pathway of this radionuclide in natural environments, taking into account that these organisms, with few exceptions, have been found to contain the highest concentrations of transuranium elements among all marine invertebrates examined to date. Two asteroids collected off Monaco, *Coscinasterias tenuispina* and *Marthasterias glacialis*, were dissected and analysed for ^{241}Am by standard chemical extraction techniques and alpha-spectrometry (BALLESTRA, 1980). *C.tenuispina* (n >100, 15 g average wet weight) was immature (gonad index = 1.3) and sexes were not visually identifiable. *M. glacialis* (n = 25, 50 g average wet weight) was mature and gonad index averaged 12 for males and 21 for females.

The results reported in Table 1 show the following :

i) the highest concentrations of ^{241}Am (C.F. = $3x10^4$) are found in the body wall which contains 84-94% of the total body burden of ^{241}Am in the two seastars.

ii) the internal organs (pyloric caeca, gut and gonads) are able to concentrate ^{241}Am to high levels ($4x10^3$ - $2.9x10^4$) although these tissues account for no more than a few per cent of the total americium body burden except gonads during the reproductive period, and particularly male gonads of *M. glacialis*. In the latter case, the fraction of total ^{241}Am fixed in gonads increases to 12% (C.F. = $2.6x10^4$).

These results confirm the very high americium concentrating ability of these marine invertebrates. If we compare these data with our previous results on plutonium accumulation in seastars (GUARY *et al.*, 1982), it appears that ^{241}Am is concentrated to a greater extent (10 times) than $^{239+240}$Pu in the tissues of these asteroids. The greater bioavailability of Am could be due to a higher percentage of particulate ^{241}Am compared to plutonium in northwestern Mediterranean waters (HOLM *et al.*, 1980).

Our experimental radiotracer studies (not shown) have demonstrated that assimilation and input through the food chain can be substantial (GUARY, 1980); however, repetitive ingestion of this radionuclide results in increased ^{241}Am excretion rates which tend to limit the buildup of this radionuclide in seastar tissues. Furthermore, our radiotracer experiments have demonstrated that when asteroids are exposed to ^{241}Am in sea water, the resultant tissue distribution of ^{241}Am closely approximates that found in seastars contaminated in the natural environment (GUARY, 1980).

Thus, we conclude from these studies that in a natural environment, seastars mostly accumulate their americium body burden directly from water.

Table 1. Concentration and distribution of 241Am in two Mediterranean seastars collected in Jan-Feb. 1978.1s errors are based on propagated counting errors.

Tissue	Wet/dry weight ratio	^{241}Am (mBq kg wet^{-1})	Total body burden ^{241}Am (%)	C.F. *
Coscinasterias tenuispina				
Body wall	3.8	63.6 ± 7.0	94.2	30 000
Pyloric caeca	4.1	27.4 ± 3.0	3.7	13 000
Gut	4.3	61.8 ± 11.8	1.9	29 000
Gonad	3.8	8.5 ± 3.7	0.2	4 000
Whole animal	-	59.9 ± 14.4	100	28 000
Marthasterias glacialis				
Body wall	3.3	62.9 ± 5.6	83.8 (♂) - 88.7 (♀)	30 000
Pyloric caeca	4.6	12.2 ± 1.5	3.4 (♂) - 4.1 (♀)	5 800
Gut	5.0	37.0 ± 3.7	0.7 (♂) - 0.8 (♀)	17 500
Male gonad	5.8	54.8 ± 2.6	12.1	26 000
Female gonad	5.2	13.7 ± 1.5	6.4	6 500
Whole animal **	-	55.5 (♂) - 44.4 (♀)	100	26 000 (♂) - 21 000 (♀)

* Concentration factors (C.F.) were calculated using reported ^{241}Am concentrations in Mediterranean coastal sea water (2.1 µBq l-1) where the seastars were collected (FUKAI *et al.*, 1976).
** Values for reconstituted animal are approximate because separate analyses for males (♂) and females (♀) were not performed for all organs.

ACKNOWLEDGEMENTS.

The IAEA Marine Environment Laboratory operates under an agreement between the International Atomic Energy Agency and the Government of the Principality of Monaco.

REFERENCES

BALLESTRA, S., 1980. Radioactivité artificielle et environnement marin. Etude relative aux transuraniens ^{238}Pu, $^{239+240}$Pu, ^{241}Pu et ^{241}Am en Méditerranée. Thèse Doct. Etat-Sciences, Univ. de Nice, 217 p.

FUKAI, R., BALLESTRA, S. and HOLM, E., 1976. ^{241}Americium in Mediterranean surface waters. *Nature, Lond.*, 264 : 739-740.

GUARY, J.C., 1980. Recherches sur les transferts et la fixation du plutonium, de l'americium et du neptunium dans le milieu marin. Thèse Doct. Etat-Sciences, Univ. Aix-Marseille II, 303 p.

GUARY, J.C., FOWLER, S.W. and BEASLEY, T.M., 1982. Routes of plutonium uptake and their relation to biomagnification in starfish. *Mar.Pollut.Bull.*,13 : 99-102.

HOLM, E., BALLESTRA, S., FUKAI, R. and BEASLEY, T.M., 1980. Particulate plutonium and americium in Mediterranean surface waters. *Oceanol. Acta*, 3 : 157-160.

R

MAIN RADIONUCLIDES OF CESIUM, PLUTONIUM AND STRONTIUM IN THE NORTHERN ADRIATIC SEA (1990 - 92)

F. NONNIS MARZANO, C. TRIULZI, M. VAGHI

Department of General Biology and Physiology. University of Parma, Viale delle Scienze, 43100 Parma, Italy

Temporal trends of radiocesium isotopes were presented in the past in papers (TRIULZI *et al.*, 1992; 1994) that dealt mostly with the influence of the Chernobyl accident on the eastern Mediterranean Sea. In this work investigations were extended to other important radionuclides such as plutonium and strontium isotopes (DESIDERI *et al.*, 1994) that contribute together with Cs-137 to the radiocontamination of the Mediterranean area because of their long environmental persistency.

Although the distribution of Sr-90, Cs-137, Pu-238 and Pu-239+240 was obtained in different ecosystem components such as seawater, pelagic and benthic organisms and sediments, major emphasis was put on the detection of the above-cited nuclides in sediment samples, due to the importance of the sediment compartment as the final point of pollution accumulation.

For this reason, samples of sediment from different strata (mostly 0-3 cm and 12-15 cm) were collected from sampling stations along transects off the main Adriatic cities during May 1990 (NONNIS MARZANO and TRIULZI, 1994). A complete mapping of radionuclide concentrations has therefore been obtained for an area located between the Gulf of Trieste and Ancona.

Samples of sediment and macrofauna were also collected in the Sacca di Goro, a salt marsh environment of the Po river delta, with the aim of comparing the marine and estuarine biogeochemical behaviour of the radionuclides. For this reason two stations were chosen inside the Sacca, a central station influenced by the tidal current and river-sea exchanges, and a recovered one with slow hydrological motion (BONDAVALLI *et al.*, 1994).

Concentrations of Sr-90 and Pu-239+240 in benthic marine organisms were generally very low, and in particular for the Pu-239+240 very close to the limits of detection. Concentrations of Sr-90 ranged between <0.5 and 1.7 Bq/kg dry while values of Pu-239+240 were variable between <0.003 and 0.093 Bq/kg dry.

However as reported above, special emphasis was put on the distribution of these isotopes in the sediment layer where concentrations were more readily detectable. In fact, concentrations of Sr-90 in the open sea sediments ranged between 1.5 and 6.44 Bq/kg dry for the surface strata and between <1.5 and 2.13 Bq/kg dry for the underlying layers. Lower concentrations were detected for the plutonium isotopes with values of Pu-239+240 in the ranges 0.21-1.23 Bq/kg dry and 0.08-1.47 Bq/kg dry for the top and underlying strata, respectively. Mean concentrations of Pu-238 were around 0.03 Bq/kg dry for both strata.

Results obtained from samples collected in the two stations of the Sacca di Goro were lower than those determined in the open sea area. Sr-90 concentrations were in the range 1.9-2.8 Bq/kg dry, Pu-238 was below the detection limits (<0.1 Bq/kg dry) and Pu-239+240 was in the range 0.05-0.15 Bq/kg dry. Nevertheless concentrations of Cs-137 and Cs-134 were much higher in this estuarine environment compared to the ones detected in the open Adriatic Sea.

Pu-238/Pu-239+240 ratios varied between 0.02 and 0.06 whereas Sr-90/Pu-239+240 ratios were in the range 5-26. These values were in good agreement with data reported by PENTREATH (1987) for the marine environment in the preChernobyl period. It is well known that the Chernobyl event has scarcely affected the Sr-90 and Pu-239+240 levels already present in the environment. In fact, fallout depositions of these isotopes during the Chernobyl period were negligible in comparison to the levels of radiocesium.

On the other hand, the Cs-137/Sr-90 ratios varied between 1 and 4 in the marine environment and were around 25 in the salt marsh. The Cs-137/Pu-239+240 ratios ranged from 5-25 in the open sea and between 466 and 600 in the Sacca di Goro. The estuarine environment therefore appeared to be a strong accumulating area of Cs-137 whereas concentrations of Sr-90 and plutonium isotopes were lower than levels detected in the Adriatic.

REFERENCES

BONDAVALLI C., NONNIS MARZANO F., TRIULZI C. 1994. Radiocesio e radionuclidi naturali in matrici ambientali della Sacca di Goro (Delta del Po). Proc. Meet. "La radioattività ambientale nell'area del Mar Meditteraneo". Isola del Giglio. May 5-7: in press.

DESIDERI D., MELI M.A., NONNIS MARZANO F., ROSELLI C., TESTA C., TRIULZI C., VAGHI M. 1994. Isotopi radioattivi dello stronzio, del cesio e del plutonio in sedimenti dell'Alto Adriatico (1990-1992). Proc. Meet. "La radioattività ambientale nell'area del Mar Meditteraneo". Isola del Giglio. May 5-7: in press.

NONNIS MARZANO F., TRIULZI C. 1994. A radioecological survey of Northern and Middle Adriatic Sea before and after the Chernobyl event (1979-1990). *Mar. Poll. Bull.* 28 (4): 244-253.

PENTREATH R.J. 1987. Sources of artificial radionuclides in the marine environment. In Radionuclides: a tool for oceanography. Elsever Applied Science: 12-32.

TRIULZI C., NONNIS MARZANO F., JELISAVCIC O. 1992. Distribution of artificial radiocontamination in the Northern and Middle Adriatic Sea (1989-90). Rapp. CIESM 33: 339.

TRIULZI C., TASSI PELATI L., NONNIS MARZANO F., JELISAVCIC O. 1994. Radioecological researches in the Adriatic Sea in the framework of the Ascop programme. Proc. Int. Conf. Marina Med, Rome: in press.

STABLE ELEMENT DISTRIBUTION STUDY IN MEDITERRANEAN TUNA BY NAA METHODS

C. PAPADOPOULOU[1], S.W. FOWLER[2], I. HADZISTELIOS[1]

[1] "Demokritos" N.R.C.P.S., Ag. Paraskevi, Athens, Greece

[2] IAEA Marine ENVIRONMENT laboratory, P.O.Box 800, MC 98012 Monaco

Instrumental neutron activation analysis (INAA) and γ-spectrometry, as well as fast radiochemical separation methods have been used for the determination of Cr, Ag, Sc, Co, V, Cs, Zn and As in bluefin tuna (*Thunnus thynnus thynnus*) from the Mediterranean Sea. The distribution of the elements was examined in muscle, liver and gut content of this pelagic fish. The stable trace elements investigated possess corresponding fission and/or neutron induced radionuclides, and some of these elements are of known biological significance for marine organisms. It was found that most of elements determined in tuna are concentrated in the liver of the fish.

Neutron activation analysis have been applied succesfully to date for the determination of many stable elements in various marine species (PAPADOPOULOU, 1992; BERNHARD, 1978). It is known that stable elements and radionuclides of anthropogenic origin entering into the oceans are accumulated by different marine organisms. The work done with tuna has been mainly related to the estimation of Hg and Se although certain other elements have been reported (IDOE 1972, FAO/UNEP 1986). To the best of our knowledge there is relatively little information as regards the distribution of stable trace elements in organs and tissues of tuna. In this paper we report concentrations of Cr, Ag, Sc, Co, V, Cs, Zn and As in tuna from five areas of the Mediterranean, determined by NAA methods. This work has been done in the frame work of UNEP/IAEA Project 1998 EP. Tuna fish samples (N=13) were collected in 1977 off the French Mediterranean coast. Sample identification and separation were done according to FAO Fisheries technical reports. From each fish, muscle, liver and gut content were separated. Moreover kidney, intestine tract and genital organs from two individual fish were also taken. The samples were lyophilised and homogenised prior to analysis. INAA and γ-spectrometry were applied for the determination of Cr, Ag, Co, Sc, Cs, and Zn while fast radiochemical separation based on solvent extraction and NAA methods were used for the determination of As and V (PAPADOPOULOU, 1972; PAPADOPOULOU *et al.*,1973 & 1978). The results obtained from this study are listed in Table 1. The values of trace element content given in this Table represent the mean value from 2-3 individuals from each sampling area.

Comparison of the element-distribution patterns in muscle and liver showed that these are mostly localised in the liver with the exception of Cs where higher values were found in muscle tissue. The high values of the elements found in gut content are most likely related to the food consumed by the fish. Taking in concideration that tuna is a pelagic fish of economical interest, it is of importance to protect the population from undesirable effects which might be caused, eventually, by the incorporation of toxic and/or radioactive trace elements entering the ocean. The baseline data reported herein could be useful for comparison with future information on the state of pollution of these areas in the Mediterranean.

TABLE 1. Stable element content in Bluefin tuna from the Mediterranean Sea

SAMPLING AREA (FRANCE) Tissues	Cr	Ag	Sc	Co	V	Cs	Zn	As
			(ng/g dry weight)				(£g/g d.w.)	
MENTON								
Muscle	92	8.7	0.30	10	48	60	17	6.3
Liver	210	130	0.67	230	130	70	85	23
Gut cont.	920	120	39	82	540	63	92	44
ANTIBES								
Muscle	75	11	0.46	9.4	6.1	140	177	8
Liver	140	230	0.64	220	110	67	100	48
Gut cont	660	120	21	52	350	370	130	28
MONACO								
Muscle	130	8.6	0.16	9.0	30	160	17	10
Liver	260	50	0.36	300	110	40	100	38
Gut cont.	510	15	3.1	47	980	250	140	11
BAY DES ANGES								
Muscle	130	8.7	0.29	13	26	140	12	7.1
Liver	150	200	4.0	270	73	86	110	20
Gut cont.	470	9 4	23	45	640	84	44	6.5
CANNES								
Muscle	87	12	0.35	4.8	20	140	9.0	10
Liver	250	260	3.5	310	170	89	130	18
Gut cont.	290	260	12	58	350	40	290	38

REFERENCES

BERNHARD M. 1978, *Ocean Management*, 3: 253-313.

FAO/UNEP 1986. *FAO Fish Rep.* 326.

IDOE 1972. Baseline sudies of pollutants in the Marine Environment and Research Recomendation IDOE Conf. 55 p.

PAPADOPOULOU C., 1972. Contribution to the Radioecology of the Greek Seas. Ph.D Thesis, Athens University, 100 p.

PAPADOPOULOU C. *et al.* 1973. Mercury and arsenic in a fish collected in polluted and unpolluted sea waters. *Thalassia Yugoslavica*, 9 : 211-218.

PAPADOPOULOU C. *et al.* 1978. Trace elements in Pelagic organisms and a Pelagic food-chain of the Agean Sea. IV Jour. Etudes Poll. Antalya CIESM : 231-232.

R

TRANSURANIC ACCUMULATION IN PLANKTON FROM THE SPANISH MEDITERRANEAN COASTAL ENVIRONMENT

J.A. SANCHEZ-CABEZA[1], J. MERINO[1], W.R. SCHELL[2], P.I. MITCHELL[3]

[1] Departament de Física, Universitat Autònoma de Barcelona, 08193 Bellaterra, Spain
[2] Center for Environmental and Occupational Health, Univ. of Pittsburgh, PA 15238, USA
3 Department of Experimental Physics, University College, Dublin-4, Ireland

Broadly speaking, zooplankton and phytoplankton include mobile and immobile microbial marine species, respectively. From a classical point of view, phytoplankton are photosynthetic organisms and zooplankton are phytoplankton consumers, therefore representing the first and second levels of the marine trophic chain. However, real food-chains may be very complex depending on the species involved (FENCHEL, 1988). In regard to size classification, a widely accepted cut-off between "classical" phytoplankton and adult zooplankton is 200 µm (SIEBURTH, 1972), though some zooplankton species may have smaller sizes (microzooplankton). Furthermore, though most phytoplankton species have dimensions larger than 20 µm, some species may also be smaller (picoplankton). For practical reasons, 20 µm and 200 µm are the adopted plankton cut-off sizes in our work. As transuranic concentrations in the Mediterranean Sea are low, zooplankton was collected by towing through surface waters, for 30-60 minutes, a large 200 µm mesh conical net (diameter: 1 m, length: 5 m) provided with a flow-meter. It should be noted that when the net saturates, some phytoplankton species may also be collected. Phytoplankton was collected by filtering large volumes of water through 20 µm depth cellulose filters (SCHLEICHER and SCHUELL, #520B). Other size fractions filtered were 8µm (Schleicher and Schuell, #AE99) and 0.2 µm (Gelman Sciences, Suporcap-100). The smaller fractions include increasingly larger proportions of suspended detrital particles. Samples reported in this work were collected during the MED'92 research expedition on board the N.O. Urania.

Phytoplankton and suspended particles. Large volume (c. 1000 liter) water samples were sequentially passed through 20 µm, 8 µm and 0.2 µm filters, and analysed for plutonium (Table 1). The phytoplankton fractions (microplankton: > 20 µm) showed activites ranging from 59-364 $\mu Bq \cdot m^{-3}$. The concentrations observed in the medium sized particles (nanoplankton: 8-20 µm), mostly constituted by small phytoplankton species, were low (28-119 $\mu Bq \cdot m^{-3}$) though smallest particles (picoplankton and suspended detritic and inorganic particles: 0.2-8 µm) showed concentrations of the same order as phytoplankton (43-218 $\mu Bq \cdot m^{-3}$). Therefore, about 50% of the particulate plutonium observed in the N.W. Mediterranean Sea appeared to be associated with the phytoplankton fraction (> 20 µm).

	Pu-239,240 ($\mu Bq \cdot m^{-3}$)		
Station	> 20 µm	8-20 µm	0.2-8 µm
Barcelona	168 ± 23	28 ± 24	144 ± 56
Golf de St. Jordi	364 ± 158	119 ± 63	218 ± 84
Garrucha	59 ± 20		43 ± 27 *

* 0.2-20 µm

Table 1. Plutonium concentrations in suspended particles (phytoplankton: > 20 µm) from the NW Mediterranean Sea, August 1992 (uncertainties = ±1σ). * 0.2-20 µm

Zooplankton. Zooplankton biomass was larger in the northern stations (Barcelona and Golf de St. Jordi, mean 18 ± 2 mg dw/m^3) indicating higher productivity related to higher nutrients input. The mean specific biomass in the Palomares area was only 5±2 mg dw/m^3. The wet to dry ratio ranged from 6 to 12. The transuranic concentrations and isotopic ratios in 4 zooplankton samples from the N.W. Mediterranean Sea are shown in Table 2. Concentrations ranged from 3.13-9.45 $\mu Bq(^{239,240}Pu) \cdot m^{-3}$ and 0.54-0.90 $\mu Bq(^{241}Am) \cdot m^{-3}$ corresponding to concentration factors (CF), computed as indicated in IAEA (1985), ranging from $(2.90\text{-}9.5) \cdot 10^3$ for Pu and $(2.9\text{-}14) \cdot 10^3$ for Am.

Location	Pu-239,240		Pu-238	Am-241		Am-241
	$\mu Bq \cdot m^{-3}$	CF $\cdot 10^3$	Pu-239,240	$\mu Bq \cdot m^{-3}$	CF $\cdot 10^3$	Pu-239,240
Barcelona	8,4 ± 0,6	4,7 ± 0,3	0,065 ± 0,014	0,54 ± 0,11	2,9 ± 0,7	0,064 ± 0,013
Golf St. Jordi	9,5 ± 0,4	8,2 ± 0,8	0,099 ± 0,011	0,9 ± 0,3	3,8 ± 1,5	0,095 ± 0,034
Palomares	3,13 ± 0,14	3,9 ± 0,2	0,026 ± 0,007	0,61 ± 0,06	7,9 ± 1,5	0,194 ± 0,021
P. Macenas	2,90 ± 0,12	4,8 ± 0,4	0,024 ± 0,008	0,80 ± 0,08	14 ± 3	0,274 ± 0,030

Table 2. Transuranic concentrations in zooplankton (> 200 µm) from the N.W. Mediterranean Sea, August 1992 (uncertainties = ±1σ).

K_d's, concentration factors and isotopic ratios. The particulate (> 0.2 µm) Pu amounted from 0.8% to 10% of the overall sea water activity, with K_d ranging from $(0.1\text{-}1.2) \cdot 10^5$ $l \cdot Kg^{-1}$. This is only slightly smaller (but within the range) than the phytoplankton CF recommended by IAEA (1985) and that reported in the literature (FISHER *et al.*, 1983). The phytoplankton (> 20 µm) CF for plutonium could not be derived as the sample mass was too low to be determined by standard methods on the filtered material.

The mean CF's for zooplankton were $4.4 \cdot 10^3$ for plutonium and $4.2 \cdot 10^3$ for americium, slightly higher (but within the range) than the values recommended by the IAEA (1985). The plutonium isotopic ratios showed the presence of bomb plutonium in the Palomares area samples (Palomares and P. Macenas), though activites were not higher. The distortion observed in the Golf de St. Jordi sample confirms the presence of plutonium from a nearby nuclear power plant (Vandellós I). The americium to plutonium ratio indicates a varying degree of sediment-originated radionuclides in the samples, going from a predominatly water origin (Barcelona) to a largely sediment origin (P.Macenas).

ACKNOWLEDGEMENTS : The authors gratefully acknowledge financial support received from the European Commission (Contract F13P-CT920046) and from the Empresa Nacional de Residuos Radiactivos (Contrato 70.2.4.11.01) to develop this work. Special thanks are given to ENEA-Sta. Teresa for inviting us to participate in the MED'92 research expedition.

REFERENCES

FENCHEL T., 1988. Marine Plankton Food Chains. *Ann. Rev. Ecol. Syst.* 19: 19-38.
FISHER N.S., BJERREGAARD P. and FOWLER S.W., 1983. Interactions of marine plankton with transuranic elements. 1. Biokinetics of neptunium, plutonium, americium and californium in phytoplankton. *Limnol. Oceanogr.* 28(3): 432-447.
International Atomic Energy Agency, 1985. Sediment Kds and Concentration Factors for Radionuclides in the Marine Environment, Technical Report Series No. 247, IAEA, Vienna: 73 p.
SIEBURTH J. McN., SMETACEK V. and LENZ J., 1978. Ecosystem Structure: Heterotrophic compartments of plankton and their relationship to size fractions. *Limnol. Oceanogr.* 23(6): 1256-1263.

ACTIVITIES OF URBINO UNIVERSITY FOR MARINE RADIOACTIVITY RESEARCH IN THE MEDITERRANEAN SEA

Corrado TESTA, Donatella DESIDERI, Maria Assunta MELI, Carla ROSELLI

Institute of General Chemistry, Urbino University,
Piazza Rinascimento 6, 61029 Urbino, Italy

Over the last ten years the General Chemistry Institute of the Urbino University (Italy) has been involved in the determination of artificial radionuclides (Plutonium and Sr-90) (TESTA *et al.*, 1990) and cosmogenic P-32 in environmental samples collected in the Mediterranean Sea area. These studies have been mainly carried out in collaboration with ENEL-CRTN (Milano), ENEA-CRAM (La Spezia) and Parma University.

The first research subject was the determination of Pu-239+240, Pu-238 and Sr-90 in sea sediment cores, surface sediments, algae and mussels. Extraction chromatography with tri-n-octylphosphine oxide (TOPO) and with di(2 ethyl hexyl)phosphoric acid (HDEHP) supported on microporous polyethylene powder (Microthene) was used for plutonium and Sr-90 (Y-90) separation, respectively (TESTA *et al.*, 1993). The determination of plutonium isotopes was obtained by alpha spectrometry after electroplating; Sr-90 was measured by counting a Y-90 oxalate source with a low background beta detector and following the Y-90 decay. The addition of Pu-242 (En α = 4.9 MeV) as the yield tracer and the analysis of the relevant alpha spectrum facilitated obtaining a precise figure for the recovery of any measure. Similarly the Y-90 chemical yield was obtained by a complexometric titration of the recovered yttrium. The accuracy and reproducibility of the method were checked by multiple analyses of IAEA and NBS certified samples.

Over the period 1985-1991 six sediments cores were collected at three different sites: Gaeta Gulf (Naples), Taranto Gulf (Ionian Sea) and Western Mediterranean Sea (Algeria). The relevant results are summarized in Table I.

Table I : Plutonium and Sr-90 in some sediment cores from the Mediterranean Sea.

Site (year)	Depth m	Core length cm	Maximum concentration (h,cm)		(Bq/kg)
			Pu-239+240	Pu-238	Sr-90
Gaeta Gulf A (1985)	50	10	2.2 (4-8)	0.06 (4-8)	27.4 (4-6)
Gaeta Gulf B (1985)	50	10	1.9 (6-8)	0.06 (6-8)	12.1 (0-2)
Gaeta Gulf (1989)	50	20	3.2 (12-16)	0.11 (12-16)	8.0 (8-12)
Taranto Gulf A (1989)	1500	15	1.0 (0-7)	0.03 (0-7)	-
Taranto Gulf B (1989)	2000	20	0.9 (7-11)	0.06 (7-11)	-
Algeria (1991)	2800	20	0.2 (0-2)	N-D	

h= core horizontal section depth

Plutonium and Sr-90 were also measured in some Northern Adriatic Sea samples (algae, mussels and surface sediments).The results were as follows :

1) Algae: plutonium concentration ranged from $<3.5\ 10^{-3}$ to $2.4\ 10^{-2}$ Bq/kg; Sr-90 concentrations varied between 0.5 and 1.7 Bq/kg.

2) Mussels: the mean plutonium concentration was $5.4\ 10^{-2}$ Bq/kg; Sr-90 concentrations were below the detection limit (0.9 Bq/kg).

3) Surface sediments: Pu-239+240 and Pu-238 concentrations (Bq/kg) ranged from $6.0\ 10^{-2}$ to 1.47 and from $<1.3\ 10^{-2}$ to $3.3\ 10^{-2}$, respectively. The Sr-90 concentration varied between <2.4 and 6.5 Bq/kg. The ratio Pu-238/Pu-239+240 and Sr-90/Pu-239+240 were 0.039 (8 samples) and 14.5 (10 samples), respectively.

The second research subject was the establishment of chemical and radioanalytical procedures for the determination of cosmogenic P-32 with the aim to evaluate the phosphorus cycle in the marine ecosystem (LAL *et al.*, 1988). For this purpose P-32, as phosphate ion, was measured in sea water, phytoplankton and zooplankton. Because of the low P-32 concentration, large water volumes had to be analyzed by retaining the phosphate ion on XAD-7 resin supporting $Fe(OH)_3$. After elution with 6 M HCl and Fe^{3+} elimination with methyl isobuthyl ketone (MIBK), phosphorus was purified by two selective precipitations as ammonium phosphomolybdate (AMP) and as $MgNH_4PO_4$. This salt was counted by a low background beta detector following the P-32 decay (T1/2 = 14.3 days). Some preliminary tests were carried out in the La Spezia Gulf (Northern Tyrrhenian Sea) where a small pilot plant with suitable filters and XAD-$Fe(OH)_3$ cartriges was checked. On the basis of the results shown in Table II, the following conclusions can be drawn. The total phosphorus concentration (3.07 mg/m^3) is in good accordance with the values reported in the literature for the Mediterranean Sea (~ 3 mg/m^3). The P-32 specific activity (302 dpm/g P) is higher than that reported by LAL *et al.* (1988) for the open ocean (100-250 dpm/g P), but this difference may be due to a river contribution in the La Spezia Gulf. The specific activity in phytoplankton+zooplankton is higher than in the dissolved inorganic phosphorus (DIP), due probably to the nonhomogeneity of the sampling site.

Table II : P-32 determination in La Spezia Gulf

Sample	Water volume (m^3)	P conc. (mg/m^3)	P-32 conc. (dpm/m^3)	Specific activity (dpm P-32/gP)
Phytoplankton + Zooplankton	100	0.09	0.03	369
Sea Water (DIP)	10	2.98	0.90	302
Total	_	3.07	0.93	-

REFERENCES

LAL D., CHUNG Y., PLATT T., LEE T., 1988. Twin cosmogenic radiotracer studies of phosphorus recycling and chemical fluxes in the upper ocean. *Limnol. Oceanogr.* 33: 1559 - 1567.
TESTA C., DESIDERI D., MELI M.A., QUEIRAZZA G., MARTINOTTI W., 1990. Measuring plutonium and 90Sr environmental concentrations at the Garigliano Power Plant Site before decommissioning. *Radioactivity and Radiochemistry*, Summer 90 : 62 - 71
TESTA C., DESIDERI D., MELI M.A., ROSELLI C., QUEIRAZZA G., BAZZARRI S., 1993. Radioanalytical procedures for the separation and determination of alpha, beta and X emitters in environmental samples of a Nuclear Power Plant before decommissioning. *Science of the Total Environment*, 130/131 : 403 - 417.

R

RADIOACTIVITY AND TRACE ELEMENT LEVELS IN SEDIMENTS OF THE BLACK SEA

Sayhan TOPCUOGLU, Deniz KUT, Nur ESEN and Rezzan KÜÇÜKCEZZAR
Çekmece Nuclear Research & Training Centre, Istanbul, Turkey

Radioactive and trace element pollution in the marine environment are usually monitored by measuring the contaminants in water, biota and sediment samples. The relative abundances of the radionuclides or trace elements in each group depend on both the properties of the sediment and biota and the chemistry of the pollutants. Element or radionuclide concentrations in sediment are relatively invariable over time compared to water and biota. Furthermore, the integrated concentrations of radionuclides or trace elements in sediments have been assumed to give the rate of pollution for comparison purposes.

Several studies have been published concerning radioactivity and trace element levels observed in some marine organisms in the Black Sea (GÜVEN *et al.*, 1990, 1992; TOPCUOGLU *et al.*, 1988, 1990). However, data on these subjects for the sediments are limited. We report here the results obtained on the concentrations of radionuclides and some elements in sediments collected from two sites along the Turkish Black Sea coast, Kilyos and Sinop (Fig.1).

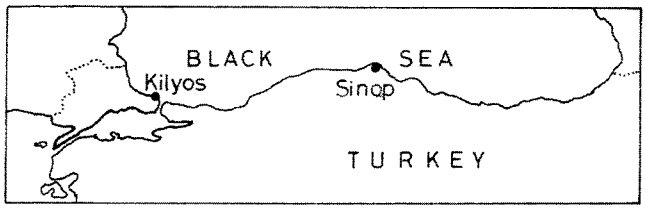


Fig. 1. The collection sites for Black Sea sediments.

The top 4 cm of sediment samples were collected near the shore of the stations using a Lenz Bottom Sampler. Sediments were stored frozen in plastic cups until analyzed. The gamma isotopic analyses were carried out using a high resolution HpGe detector coupled to a multi channel analyzer. The trace element levels in sediment samples were determined by instrumental neutron activation analysis. Other procedures were similar to those previously described (TOPCUOGLU *et al.*, 1988, 1990). ^{137}Cs and ^{238}U activities in the Sinop sample are higher than those found in sediment collected from Kilyos (Table 1). For ^{137}Cs, this is an expected result if we consider the location of Sinop in relation to the Chernobyl fallout pattern. On the other hand, ^{232}Th and ^{40}K levels in the Sinop sample are lower than concentrations in Kilyos sediment. However, more data on radionuclides in sediments are needed before any clear pattern on radioactivity distribution in this area of the Black Sea can be discerned.

Table 1. Radionuclides in sediment samples collected from the Black Sea in January 93.

Sampling site	Bq Kg^{-1} dry weight			
	^{137}Cs	^{238}U	^{232}Th	^{40}K
Sinop	9.3 ± 3.9	26.2 ± 12.3	<1.3	152 ± 37
Kilyos	3.2 ± 1.2	4.9 ± 1.6	5.5 ± 2.4	225 ± 18

The trace element contents of the sediment samples are shown in Table 2. Concentrations of As, Cr, Rb, Fe, Zn and Ba showed considerable variations. There is no significant difference among the concentrations of Ce, La, Cs, Sc, Co and Sb. Arsenic is higher in Kilyos sediment; but Cr and Zn are much lower than corresponding levels found in the Sinop sample. However, many factors (river discharges, mining wastes, etc.) can cause these variations. Present data are thus insufficient to draw any definitive conclusion regarding contamination levels.

Table 2. Trace element concentration (μg g^{-1}) in dry sediment samples collected from the Black Sea in January 1993.

Sampling site	As	Ce	La	Cr	Sc	Rb
Sinop	3.9 ± 0.8	7.36 ± 1.14	3.86 ± 0.58	18.1 ± 1.9	1.91 ± 0.08	10.6 ± 3.1
Kilyos	42.8 ± 13.8	10.20 ± 1.50	5.59 ± 1.00	4.4 ± 0.6	0.77 ± 0.04	32.4 ± 5.2
	Cs	Fe	Zn	Co	Sb	Ba
Sinop	0.60 ± 0.15	5587 ± 118	15.0 ± 2.6	2.15 ± 0.13	0.27 ± 0.06	72 ± 32
Kilyos	0.45 ± 0.10	3238 ± 74	3.8 ± 1.4	1.29 ± 0.09	0.22 ± 0.05	293 ± 43

Se, Hg and Ni levels were below the detection limits.

R

REFERENCES

GÜVEN K.C., PLEVNELI M., CEVHER E., TOPCUOGLU S., KÖSE N., BULUT M. & BAYÜLGEN N., 1990. - The radioactivity level of Black Sea marine algae before and after the Chernobyl accident. *Toxicol. Environ. Chem.*, 27: 297-302.

GÜVEN K.C., TOPCUOGLU S., KUT D., ESEN N., ERENTÜRK N., SAYGI N., CEVHER E., GÜVENER B. & ÖZTÜRK B., 1992. - Metal uptake by Black Sea algae. *Bot. Marina*, 35: 337-340.

TOPCUOGLU S., BULUT A.M., BAYÜLGEN N., KÜÇÜKCEZZAR R. & KÖSE N., 1988. - Radioecological studies in Black Sea fish after the Chernobyl accident. 1st. National Medical Physics Meeting, pp. 264 - 268, Istanbul.

TOPCUOGLU S., ERENTÜRK N., SAYGI N., KUT D., ESEN N., BASSARI A. & SEDDIGH E., 1990. - Trace metal levels of fish from the Marmara and Black Sea. *Toxicol. Environ. Chem.*, 29: 95 - 99.

V

COMITÉ VERTÉBRÉS MARINS ET CEPHALOPODES

Président : Pere OLIVER
Vice-Président : Costas PAPACONSTANTINOU

SOME ASPECTS OF GROWTH AND RECRUITMENT OF HAKE IN THE NORTHERN TYRRHENIAN SEA

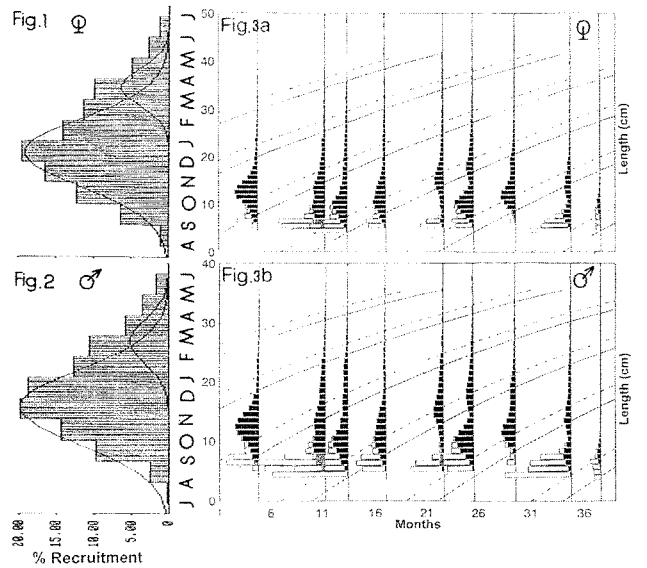
A. ABELLA, R. AUTERI, F. SERENA

Consorzio Regionale di Idrobiologia e Pesca, Livorno, Italia

Growth performance of hake in the Mediterranean Sea has been studied with results not always in agreement by several authors. Age reading of otholits of *Merluccius* is difficult, mainly for older individuals. Length frequency analyses are frequently used to estimate the Von Bertalanffy parameters assuming that the modes represent year classes. In this paper, the recent methodology for growth parameter estimation MULTIFAN (OTTER RESEARCH, 1992) has been utilized for the Northern Tyrrhenian Sea hake. It is an integrated data analysis system for simultaneously analyzing sets of length-frequency samples. It utilizes a robust maximum likelihood method to estimate the proportions of fish at age in each sample and the Von Bertalanffy growth model parameters. Extra restrictions can be introduced and superior estimates of the parameters could be obtained. The program tests some hypotheses of the occurrence of certain processes in the population sampled namely : sampling bias for the first cohort, age-dependent standard deviation in length-at-age, seasonally oscillating growth. ORSI RELINI *et al.* (1992), SARANO, (1986), ZUPANOVIC (1968) have found for hake multiple spawning and recruitment periods. It is quite difficult to trace a single reliable growth curve through the jumble of modes generated by "multiple" spawning strategies. Uncritical use of modal progression analysis algorithms leads to a possible underestimate of growth constant. K. MULTIFAN has no special routines for fitting growth curves when two or more cohorts are present each year but it has been demonstrated that it gives reliable estimates of growth parameters even for situations like the described above. Length distributions of 9 trawl-surveys performed from 1992 to 1994 with a stratified random design were analyzed separately by sex. Because macroscopic sex identification for individuals smaller than 9 cm was difficult, it was considered valid here to arbitrarily assign half part of them to each sex, considering negligible at this age sexual differences in size according to ALDEBERT *et al.* (1988). The incorporation of constrictions for the first length bias correction improved significantly the fit. The traditional mediterranean bottom trawl nets utilized as sampler during the trawl-surveys is not suitable for the catch of large individuals (ALDEBERT *et al.*, 1993). However, it has been considered that the scarce number of individuals of large size did not alter the precision of the estimates proposed here. In the table are reported the estimates of V.B. growth parameters :

	MALES			FEMALES		
	ESTIMATE	C.V.	CONF.LIMITS	ESTIMATE	C.V.	CONF.LIMITS
Loo	53.40	.39	± 0.16	79.10	.24	± 0.142
K	.27	.48	± 0.0009	.19	.24	± 0.003

The hypothesis of seasonal growth has been tested but without producing any improvement of the estimates. Other estimates of $L\infty$ of 77.4 for males and 95.7 for females were obtained with the Powell-Wetherall method (SPARRE *et al.*, 1987). It has been studied the gear selectivity utilizing a cover at the net codend. Selection for the former year classes has been modelized with a logistic function. The partial recruitment was calculated by means of analyses of the left side of the "length converted catch curve". Recruitment patterns were obtained using the appropriate routine of ELEFAN II program (Figs.1 and 2). Two peaks have been detected in December and March for females and in November/December and February for males. In both cases the late Autumn peak was bigger. These indications are in agreement with the results given in ORSI RELINI *et al.* (1992), specially for females. These authors stated that recruitment occurs approximately 6 months after spawning. Figures 3a and 3b show the length frequency distributions for females and males during each trawl-survey. The length distributions have been corrected (in white) for gear selectivity. It is shown how well the estimated growth curves with departure from the two main recruitment moments fit the peaks of the length distributions ordered along the time.



REFERENCES

ALDEBERT Y., CARRIES C. - 1988. ProblÈmes d'exploitation du merlu dans le golfe du Lion. FAO Rapp. Pêches, (395) : 87-91.

ALDEBERT Y., RECASENS L., LLEONART J. - 1993. Analysis of gear interactions in a hake fishery: The case of the Gulf of Lions (NW Mediterranean). *Sci. Mar.*, 57(2-3) : 207-217.

ORSI RELINI L., FIORENTINO F., ZAMBONI A. - 1992. Growth of Mediterranean hake. Experiences gained in the Ligurian Sea. Proceedings of 25 th E.M.B.S. Symposium : 307-315.

OTTER RESEARCH - 1992. User's Guide and References Manual. MULTIFAN 3. Otter Research Ltd.Nanaimo.: 102.

PAULY D. - 1984. Length converted catch curves. A powerful tool for fisheries research in the tropics (Part I) ICLARM *Fishbyte*. 1 (2): 9-13.

SARANO F. - 1986. Cycle ovarien du Merlu, *Merluccius merluccius*. poisson à ponte fractionnée. *Rev. Trav. Inst. Peches marit.*, 48: 65-67.

SPARRE P., URSIN E., VENEMA S. C. - 1987. Introduction to tropical fish stock assessment. Part 1 .Manual. FAO Fisheries Technical Paper. N°. 306.1. Rome, FAO. 337p.

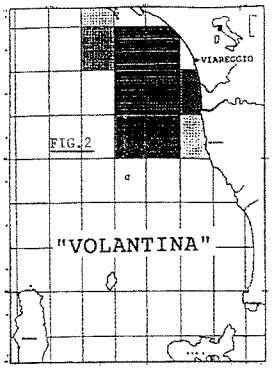
ZUPANOVIC S. - 1968. Study of hake (*Merluccius merluccius* L.) biology and population dynamics in the Central Adriatic. FAO GFCM Stud. Rev., 32: 1-24.

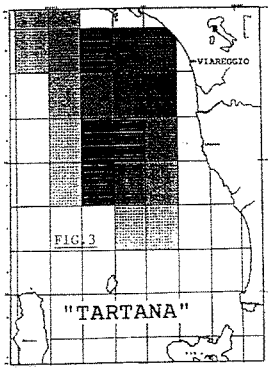
DEFINITION OF THE GROUNDFISH ASSEMBLAGES CAUGHT OFF THETUSCANIAN COASTS FOR FISHERIES MANAGEMENT PURPOSES

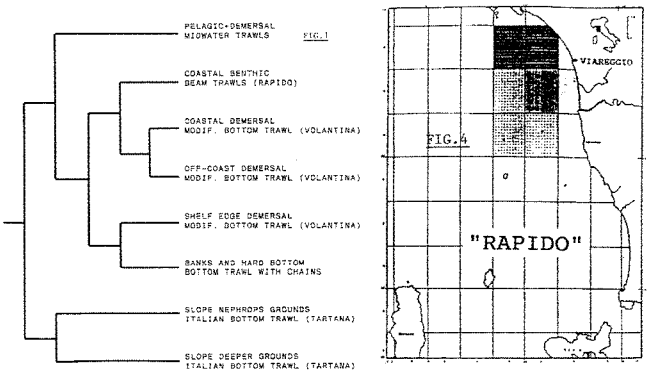
A. ABELLA, F. SERENA

Consorzio Regionale di Idrobiologia e Pesca, Livorno, Italia

The demersal fisheries operating off the coasts of Viareggio, Tuscany are multispecific. Target species, fishing gears, fishing grounds change over the year. The "Italian bottom trawl net" ("tartana") is utilized in deep waters mainly for *Nephrops*, beam trawls ("rapido") in coastal waters with soles as target species, trawl nets with the groundrope with heavy chains in hard bottoms for sparids. A variant of the Italian otter trawl net ("volantina") is utilized near shore with gobies, cuttlefish, mantis shrimp, red mullet and *Eledone* spp. as target species. The midwater trawl catch includes some demersal species. Multivariate data of a catch assessment survey performed during 1992 were analyzed by arranging them in an ordered two-way table (TWINSPAN) and with the Detrended Correspondence Analysis (DECORANA). Both algorithms are included in the Cornell Ecology Programs Package, (1990). Species abundance data matrix contained information on 342 fishing trips with approximately 1200 tows and 282 species. Assemblages of co-occurring demersal fishes by fishing strategy represent seasonally invariant groupings by fishing gear and strategy and provide an accurate description of the commercially exploited species mixes. Clustering techniques can be applied to trawl-surveys data. However, the groups defined should not be consistent with those proceeding from the analysis of commercial landings. This is because trawl surveys utilize a standardized strategy and a single trawling gear. In this paper, clustering was performed with the aim to provide definitions of fisheries in particular area/gear/depth/month combinations with characteristic species mixes. Fig.1 shows the more consistent assemblages that have been derived. There is a strong agreement between the strategical goal (target species) and the corresponding assemblage designation. The clusters showed a very reduced degree of overlapping. The DCA program derived four axes in order of decreasing correspondence between the catch and species "scores". The first two axes represents a clear separation of catches determined mainly by the fishing gear. The *a priori* defined fishing strategy, based on gear, depth and target species appears accurate and effective and allows to predict the assemblages to be caught. Figs.2-4 show the geographical distribution of effort for the main groundfish fishing strategies in the area and the relative fishing pressure exercised by statistical division. Most of the smaller fishing trawlers utilize the "volantina" and are concentrated close to Viareggio. They represent approximately 60% of the total daily trips of the fleet. The importance of the single components for a certain fishing gear changes along the year. For example, *M. barbatus* landings are abundant in late Summer-Autumn, when age class 0 individuals are concentrated near the coast. The fluctuations regarding a single species (*Mullus, Sepia,* etc.) and areal shifting are detected with the clustering technique making subdivisions at the 5th or 6th level. During Summer, with good weather conditions, the fleet is able to go further in deeper waters and the "tartana" is more frequently used. *N. norvegicus, P. longirostris, M. poutassou,* the squids *T. eblane and I. coindetii, Lophius spp, L. boscii* are the main components of the "tartana" assemblage. Some fishing vessels exploit *Nephrops* grounds placed quite far from Viareggio. The beam-trawls are more utilized during Summer. *Solea* sp, *Penaeus kerathurus* and *Raja asterias* are the main components of this assemblage. During the whole year, but specially when anchovy schools are detected, part of the fleet changes strategy and utilizes the mid-water trawl net. Anchovy by-catch is mainly composed by *Sardina* sp. and other Clupeids and Mugilids, but also by demersal species as *Diplodus* spp and *M. merluccius.*







REFERENCES

MOHLER, C.L.. 1987. Cornell Ecology Programs. MS-DOSMicrocomputer Package. Microcomputer Power, Ithaca, NY. : 51.

V

ESTIMATION DE LA CROISSANCE DU MERLU DANS LE GOLFE DU LION PAR L'ANALYSE DES FRÉQUENCES DE TAILLES

Yvonne ALDEBERT[1] et Laura RECASENS[2]

[1] IFREMER, 1 rue Jean Vilar, 34200 Sète, France
[2] CSIC-ICM, Plaça del Mar s/n, 08039 Barcelone, Espagne

Les problèmes posés par la croissance de *Merluccius merluccius* en Méditerranée n'ont pu être résolus de façon entièrement satisfaisante par les méthodes classiques de lecture d'âge sur les otolithes. En 1992, dans le cadre du programme CEE/FAR "Etude pour l'aménagement et la gestion des pêches en Méditerranée occidentale", a été crée un groupe de travail ayant pour objectif la mise au point d'une méthodologie, commune à tous les laboratoires participants, conduisant à l'estimation de paramètres de croissance comparables dans les différentes régions. Les méthodes retenues par le groupe sont basées sur les analyses de distributions de fréquences de taille. Elles ont été appliquées aux données disponibles pour le golfe du Lion. Deux séries de données ont permis la constitution d'histogrammes de taille établis respectivement sur la base d'échantillonnages mensuels des captures françaises et espagnoles. La distribution par sexe a été obtenue grâce à un sexe-ratio annuel moyen par classe de taille. Les histogrammes ont été regroupés par trimestre pour des intervalles de taille de 2 cm, avec lissage sur 3 classes consécutives. Chacune des deux séries de données a fait l'objet d'analyses indépendantes, permettant ainsi une première validation des résultats. Trois logiciels différents ont été utilisés pour les analyses; celles-ci consistant en :

— Décomposition des histogrammes trimestriels (moyenne des années 1988 à 1991) en courbes normales par la méthode de BHATTACHARYA (logiciel ELEFAN/MPA). A partir des résultats, évaluation des paramètres de croissance avec Fishparm en attribuant un âge aux différents modes et en tenant compte de l'existence possible de 2 recrutements annuels. Les calculs ont porté sur le suivi d'une cohorte, de la moyenne trimestrielle des 4 années et de la moyenne sur 4 années d'un même trimestre,

— Avec les mêmes fichiers, estimation des paramètres de croissance par année et pour la moyenne 1988-1991 (logiciel ELEFAN/ELEFAN-1),

— Essais avec le logiciel MULTIFAN pour les données de 1991 (histogrammes trimestriels en prenant en compte l'existence d'un ou deux recrutements annuels).

Les résultats des trois méthodes sont résumés dans le tableau ci-dessous.

	FEMELLES					MALES				
	ELEFAN		FISHPARM		MULTIFAN	ELEFAN		FISHPARM		MULTIFAN
	a	b	c	d	e	a	b	c	d	e
L inf.	114.8	117.7	98.6	100.7	122.9	86.4	78.5	72.8	77.9	73.0
k	0.150	0.153	0.165	0.124	0.076	0.212	0.219	0.149	0.123	0.144
to	-0.001	0.045	0.165	-0.350	-0.951	0.034	-0.041	-0.383	-0.590	-0.385

ELEFAN. Les deux séries d'histogrammes conduisent à des estimations de k et L_{inf} pratiquement identiques pour les femelles (fig.1, Fa et Fb). Pour les mâles (fig. 2, Ma et Mb), les différences sont plus importantes. A âge égal, les écarts de taille entre femelles et mâles sont relativement faibles. to a été calculé pour deux valeurs de la taille à l'âge de 1 an, 16 et 12 cm, valeurs choisies comme vraisemblables en fonction des connaissances sur la croissance des juvéniles.

BHATTACHARYA-FISHPARM. Pour chaque distribution trimestrielle, on a retenu les valeurs modales donnant la meilleure probabilité (plus faible valeur de Khi-2). L'estimation des paramètres de croissance a été ensuite faite avec FISHPARM. Les résultats montrent une variabilité importante d'une analyse à l'autre, spécialement dans le cas du suivi d'une cohorte où le risque de subjectivité est élevé. On a retenu les résultats de l'analyse du meilleur trimestre. Les courbes sont présentées sur les figures 1 (Fc et Fd) et 2 (Mc et Md).

MULTIFAN. Quelques essais seulement ont pu être été réalisés sur une seule série de données. Deux hypothèses, existence d'un ou deux recrutements annuels, ont été testées et seule la deuxième a été retenue pour les résultats finaux (fig 1, Fe et 2 Me). Pour les femelles, le jeu de valeurs retenu est celui correspondant au meilleur ajustement aux données, déterminé par un sous-programme du logiciel.

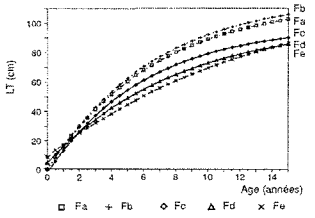


Fig. 1.- Courbes de croissance des femelles

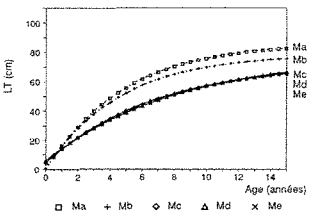


Fig. 2.- Courbes de croissance des mâles

La comparaison des résultats fait apparaître une assez grande variabilité des valeurs de k et L_{inf} d'une méthode à l'autre mais, dans tous les cas, les valeurs obtenues traduisent des taux de croissance supérieurs à ceux admis jusqu'à présent pour le merlu du golfe du Lion, du moins pour les études basées sur de lectures d'otolithes (ALDEBERT et CARRIES, 1988; RECASENS, 1992). Pour effectuer un choix parmi les différents résultats, on s'est appuyé en premier lieu sur les connaissances antérieures sur la biologie et la croissance du merlu en Méditerranée et dans d'autres mers. Ainsi une récente étude portant sur des lectures d'anneaux journaliers de croissance et sur la progression modale des juvéniles de merlu conclut à une croissance mensuelle de 1 à 1.2 cm environ (MORALES-NIN et ALDEBERT, 1994). On a également tenu compte du sexe-ratio en fonction de la taille qui fait apparaître une prépondérance des mâles pour les tailles inférieures à 38 cm. Les résultats de FISHPARM/BHATTACHARYA correspondent le mieux à ces critères et en définitive nous avons choisi les paramètres suivants:

femelles	$L_{inf.}$ = 100.7	k = 0.124	t_o = - 0.350
mâles	$L_{inf.}$ = 72.8	k = 0.149	t_o = - 0.383

Il résulte de ces valeurs qu'en Méditerranée *Merluccius merluccius* semble avoir un taux de croissance équivalent à celui observé en Atlantique, au moins au cours de ses premières années de vie.

RÉFÉRENCES

ALDEBERT Y. et CARRIES C., 1988. Problèmes d'exploitation du merlu dans le golfe du Lion. *FAO Rapp. Pêches*, 395 : 87-91.

MORALES-NIN B. et ALDEBERT Y., 1994. Growth and birthdate distribution of juvenile *Merluccius merluccius* in the gulf of Lions .... *In* : Farrugio *et al.* Etude pour l'aménagement et la gestion des pêches en Méditerranée occidentale (2e partie), Rapport final CEE/FAR MA 1-232 (mimeo).

RECASENS L. 1992. Dinámica de poblacions i pesqueria del lluç (*Merluccius merluccius*) al golf de Lleó i la mar Catalana. Ph.D. Thesis, Univ. Barcelona, 398 p

GROWTH OF FEMALE HAKE IN THE BALERIC SEA: A PROPOSAL OF NEW GROWTH MODEL WITH HIGHER GROWTH RATES

F. ALEMANY & P .OLIVER

Centro Oceanogràfico de Baleares. I.E.O. Muelle de Poniente, s/n, Apdo.291.C.P.07080, Palma de Mallorca, Spain

With the hake as the target species of the trawling fleet in the Mediterranean sea, it is essential to know its growth performance in order to apply analytical models of populations dynamics. This allows one to understand and predict the evolution of the exploited stocks. So, many studies about the growth of Mediterranean hake have been carried out for several decades; but up to now the results cannot be considered as definitive due to some methodological problems. Specialists have not reached an agreement in interpreting otoliths or scales (OLIVER *et al.*, 1990) and it is difficult to observe clear modal progressions in length frequency samples. The variability of sampling methods and base data processing also biases the results. Within the framework of a CEE/FAR project (FARRUGIO *et al.*, 1994) a working group was formed with the main objective of study growth of hake in several areas of Western Mediterranean, applying a consensuated methodology for estimating Von Bertalanffy growth parameters from length frequency analysis. Some of the results obtained referring to the growth of hake in the Balearic Islands are given later. The base data for carrying out this study were the monthly length frequency distributions of the hake landed in Palma harbour in the years 1990 and 1991, which were obtained by aleatory stratified sampling taking into account the three commercial categories into which the catch is separated. The weighted length frequency distributions were separated into male and female ones, grouped together quarterly and smoothed by using a running average over 3 consecutive size data.

The resultant quarter length frequency distributions were broken down into normal components by using Battachaya's method. For females each length frequency distribution was composed of three to five normal groups. Growth of males was not studied with this method because only two modes appeared at each length frequency distribution and modal progression could not be distinguished. The obtained modal lengths for female distributions are shown in Figure 1. It must be pointed out that expected distributions, with the exception of the first quarter of 1990, were not significantly different from the observed ones. On the other hand, the mean value of the standard deviations from the modal value of each normal component was 2.88, with a standard deviation of 0.64.

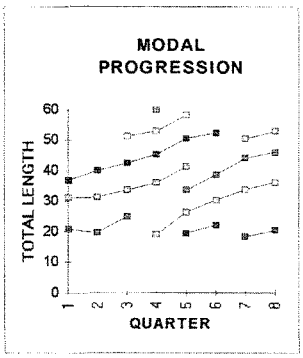


Figure 1.Female hake quarter modal lengths calculated by means of Battacharyais method.

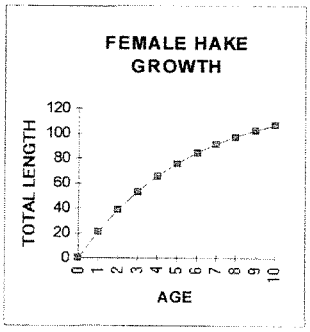


Figure 2. Proposed growth model for female hake of the Balearic Islands stock.

Two main conclusions can be drawn from these results : it seems to be an evident progression of the modal lengths along the years and the temporal distance between two consecutive cohorts is not one year, but only about six months. In order to obtain the Von Bertalanffy growth parameters, an age of one year was given to the first detected modal size of the second quarter of 1990, taking it as a reference point for assigning the remaining ages. This age was calculated taking into account the projection on the axis X of the lines that fit the development of the modal sizes of each, the value of the length increment in the second year and the spawning peaks detected in this area. From these "length at age" data, with exception of two with an age of 0.75 years, which were probably biased due to the rejection of specimens smaller than 18 cm because of the minimum legal size, growth parameters were calculated by using the FISHPARM software package. Results are shown in Table 1. The asymptotic error of Loo is high because of the lack of length at age data of specimens older than 3.5 years. The proposed growth model for female hake of the Balearic Island stock is shown in Figure 2.

Paramet.	Estimate	Asymptotic Std Error	Coef.Variatio
L.inf	126.9	45.70	0.360
K	0.184	0.094	0.514
To	0.035	0.146	4.089

Table 1.Estimated Von Bertalanffy growth parameters for female hake in Balearic Islands.

This growth rates are much higher than those generally accepted, based on otoliths reading; but they agree absolutely with a growth model for Atlantic hake presented recently at the 1993 ICES meeting (PIÑEIRO & PEREIRO, 1993) and with the only datum which we know from tagging experiments for this species (BELLOC, 1935), where a recaptured specimen had grown 11.7 cm in 8.5 months. On the other hand, the existence of two main annual cohorts, one autumn spawned and the other winter/spring spawned, have been mentioned by several authors in this area (BRUNO *et al.*, 1979; ORSI-RELINI *et al.*, 1986).

Due to the sampling technique, which is not the most appropriate for growth studies because it does not take into account the recruits neither the larger half part of the population in relation to the total length, these results can only be considered as provisional. However, we think they are coherent enough to make clear the necessity of carrying out further studies in order to solve this question, because if this hypothesis was demonstrated as certain, it would change our understanding about the population dynamics of hake in the Mediterranean.

REFERENCES:

OLIVER P., ALVAREZ F. and MORALES-NIN B., 1990. FAO Rapport sur les pêches, 447 : 79-84.

FARRUGIO H. *et al.*, 1994. CEC. Contract n° MA3-621. Final Report, February 1994.

PIÑEIRO C. and PEREIRO J.A., 1993. ICES C.M. 1993/G 12.

BELLOC G., 1935. *Rev. Trav. Off. Pêches marit.*, Nantes, 8 (2) : 145-202.

BRUNO J. *et al.*, 1979. *Rapp. Comm. int. Mer Médit.*, 25/26 (10) : 79-8

ORSI-RELINI L, FIORENTINO F. and CAPPANERA M., 1986. *Rapp. Comm. int. Mer Médit.*, 30(2): 224

V

REPRODUCTIVE BIOLOGY AND FECUNDITY OF *MERLUCCIUS MERLUCCIUS* (LINNAEUS, 1758) IN THE NORTHERN TYRRHENIAN SEA

Franco BIAGI[1], Andrea CESARINI[2], Mario SBRANA[1], Claudio VIVA[2]

[1] Dipartimento di Scienze dell'Ambiente e del Territorio, Università di Pisa, Italy
[2] Centro Interuniversitario di Biologia Marina, Livorno, Italy

In the framework of a research program aimed at gaining greater biological knowledge of the Mediterranean hake, *Merluccius merluccius*, a study was begun on the reproductive strategy of this species by sampling fishes of large size from commercial landings in the Northern Tyrrhenian Sea. Specimens were sampled from commercial landings in Porto Santo Stefano during 1992 on a monthly basis and fecundity studies were carried out. The characterization of the main stages of the sexual cycle was achieved both by visual inspection of ovary morphology and ponderal analysis as well as by histological examination. SARANO's (1986) maturity scale was followed for females, whereas HOLDEN AND RAITT's (1974) partial spawner maturity scale was followed for males. The section thickness ranged from 10 µm to 15 µm and the staining was carried out by two different treatments with Elrich Ematossilin and Mallory solutions. The oocyte population study and the fecundity estimation were achieved using volumetric method on ovaries kept in Gilson's fluid for over three months and then sieved with six nets of decreasing mesh size (840-100 µm).

Both the polymodal distribution in the oocyte population and the recovery of postovulatory follicles in ovaries in an advanced stage of development, induced us to classify this species as partial spawners, in agreement with other authors (SARANO, 1986; TSMENIDIS & PAPACONSTANTINOU, 1985). The analysis of the percentage of fishes with different maturity stages and the variation of the gonadosomatic (G.I.) and hepatosomatic (H.I.) indices during the year (Fig. 1) led us to identify three peaks, around the months of February-March, May and September, when the reproductive activity was most intense. However, fishes in advanced maturity stages are found throughout the year. The histological observations we made, showing affinity with two different colours, and the different morphology of the vitellogenic granules, demonstrated the presence of two distinct vitellogenic phases. The first phase of vitellogenesis begins when the first vitellogenic vacuoles appear; the oocyte diameter is about 100 µm and the nucleoplasmatic ratio (NPR) is near 0.5. The second phase of vitellogenesis begins when the second type of vitellogenic vacuoles appear, larger than the first type and with a different chromatic affinity; the oocyte diameter is about 300 µm and NPR=0.3. The hydrate oocyte (hyaline) sizes were found to be within the range 600-650 µm (about 930 µm fresh), smaller than in the literature (SARANO, 1986). The absolute fecundity (KARTAS & QUIGNARD, 1984) associated with these small oocyte diameters, obtained by counting the number of oocytes with a diameter larger than 170 µm, the lower threshold of vitellogenic eggs, turned out to be much higher than for SARANO (1986), with a maximum of 2,916,450 for a female of 75.5 cm total length (T.L.). The relationships between fecundity and length (Fig. 2) and between fecundity and eviscerated weight, calculated on 40 specimens, supplied a multipli-cative relationship in the first case of the type $F = a.L^b$, with b=3.07 and a=2.54 (R^2=0.74), and a linear relationship in the second case of the type $F = a + b.W$, with a=-77188 and b=614.17 (R^2=0.85). The relationship between the number of members in the group with the largest oocytes and the number of vitellogenic oocytes found in the ovaries of 17 females in the prespawning phase (when the 520 µm group is clearly evident) allowed us to estimate that the number of successive depositions is between 3 and 5. Other important aspects for understanding the biology and the dynamics of a species are represented by the smallest size of maturity and the size of first maturity, the latter being estimated by logistic functions. For the males (n=1062) with a maturity stage higher than or equal to III (mature), the two sizes turned out to be 17 cm and 27 cm respectively, whereas for the females (n=584), considering stages that are equal to or higher than II (maturing), they were 23.5 cm and 42.5 cm. Nevertheless the smallest female in prespawning stage was 35.5 T.L.. Such values agree with those of other authors as far as male maturity is concerned but they do not agree with female size at the onset of sexual maturity, as this is much higher. The results obtained with this type of research allow us to clarify some points on the reproductive biology of Merluccius merluccius and add new original data to the few works on the fecundity of the Mediterranean hake, giving insight into the selected reproductive strategy. The long spawning season and the high fecundity suggest that the hake's investment in reproductive energy is very high. The large size of first maturity together with a high number of small eggs showed that reproductive strategy would be able to keep the hake role in the ecosystem and attenuate fluctuations in year class strength.

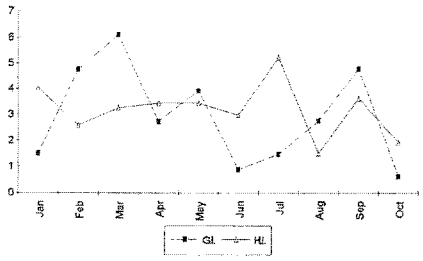


Fig 1: Monthly variations of gonadosomatic and hepatosomatic indices

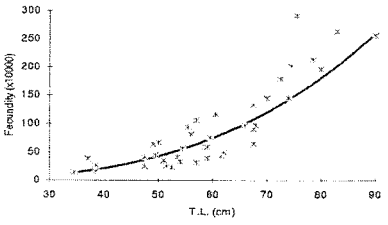


Fig 2: Fecundity-length relationship

REFERENCES

HOLDEN M.J., RAITT D.F.S., 1974 - Manual of fisheries science part 2. Methods of resource investigation and their application. *Fish. Tech. Paper* n°115, revision 1, 241 pp.

KARTAS F, QUIGNARD J.P., 1984 - La fecondité des poissons Téléostéens. Collection de Biologie des Milieux Marins. Vol 5 : 1-121.

SARANO F., 1984-1986 - Cycle ovarien du merlu, *Merluccius merluccius*, poisson à ponte fractionnée. *Rev. Trav. Inst. Pêches marit.*, 48 (1 et 2): 65-76.

SBRANA M., BALCARI P., 1993. Nota sulla presenza di femmine mature di *Merluccius merluccius* Toscano Meridionale. *Biol. Mar., suppl. al Notizario SIBM*, 1 : 375-376.

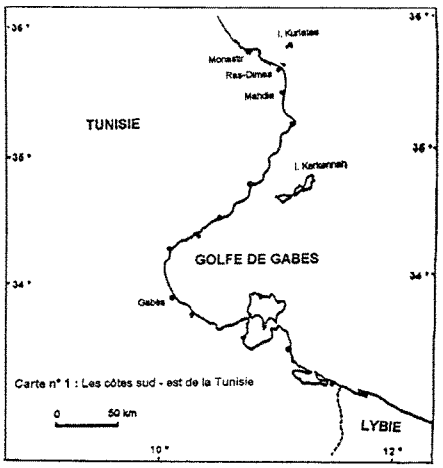
TSIMENIDIS N., PAPACOSTANTINOU C., 1985 - A preliminary study of the fecundity of the hake *(Merluccius merluccius* L. 1758) in the Greek Seas. *Inv. Pesq.*, 49 (1): 55-59

NIDIFICATION DE LA CAOUANNE *CARETTA CARETTA* SUR LES PLAGES SUD-EST DE LA TUNISIE

Mohamed Nejmeddine BRADAI

Institut National Scientifique et Technique d'Océanographie et de Pêche, Sfax, Tunisie

La caouanne *Caretta caretta* est, de loin, la tortue marine la plus commune en Tunisie. Les données anciennes et récentes certifient la présence de cette espèce, en grand nombre, le long des côtes sud-est du pays (région du golfe de Gabès). Bien que non fondées sur des informations précises, plusieurs mentions de la nidification de cette espèce ont été évoquées dans cette région (ARGANO, 1979). LAURENT *et al.* (1990) ont localisé pour la première fois, en septembre 1988, un nid de *C. caretta* sur la grande île kuriate et ont prouvé l'existence de pontes sur la plage située entre Ras-Dimas et Mahdia (carte 1). Dans cette note, nous exposons les résultats d'une mission effectuée en 1993 et financée par le RAC/SPA.



La présente étude concerne les côtes sud-est de la Tunisie de Monastir à la frontière tuniso-lybienne, environ 500 km appartenant au bassin oriental de la Méditerranée, soit 40% des côtes maritimes du pays. Ces plages d'une longueur totale de 60 km environ représentent 15% de l'ensemble des plages sableuses tunisiennes estimé à 400 km (LAURENT *et al.*, 1990). Les prospections ont été effectuées à pied et les différents sites ont été visités plusieurs fois aux périodes présumées de ponte et d'émergence des nouveaux-nés. Les îles Kuriates ont été visitées grâce aux pêcheurs de la région. Par ailleurs, et à côté des visites de terrain, des enquêtes ont été menées auprès des pêcheurs et riverains pour en savoir plus sur l'historique des plages concernées par l'étude.

Au cours de cette mission, nous avons mis en évidence pour la première fois la nidification de la caouanne sur la petite Kuriate et l'importance de ce phénomène sur la grande Kuriate. Sur les autres sites, aucune trace de ponte n'a été détectée bien que les enquêtes menées auprès des pêcheurs confirment l'importance de la nidification dans le passé entre Monastir et la frontière tuniso-lybienne.

Les îles Kuriates, situées au large de Monastir à 15 km environ des côtes, comprennent une petite île de 0,7 km^2 et une île plus grande de 2,7 km^2. Celles-ci ont été visitées les 4, 5 et 6 août 1993. Nous avons observé sur la grande Kuriate plusieurs traces plus au moins anciennes de montée de femelles et 11 nids au total ont été décelés. Ceux-ci sont situés de 13 à 16 m des laisses de mer. Sur la petite Kuriate, 7 traces de femelles nidifiantes ont été décelées, mais l'une d'elles n'aboutit pas à un nid. Deux nids ont été trouvés vidés de leurs oeufs. L'île, non habitée, est fréquentée très souvent par les pêcheurs et les baigneurs. Une deuxième prospection des plages sur la grande Kuriate, le 4 septembre 1993, nous a permis d'examiner 4 nids repérés surtout par les traces des nouveaux-nés. Plus tard, le 25 décembre 1993, un 5e nid a été découvert sur le même site.

Les différentes informations concernant ces nids sont consignées dans le tableau 1.

	04-Sep-93				25-Déc-93
	nid (1)	nid (2)	nid (3)	nid (4)	nid (5)
petits vivants	3	Eclosion non encore entamee	en pleine eclosion	2	0
petits morts	0			18	0
oeufs éclos	88			84	52
oeufs non éclos	6			46	17
taux d'éclosion	93,62%			64,62%	75,36%
taux d'émergence	93,62%			50,77%	75,36%

Table 1. L'éclosion et l'émergence des nouveaux-nés sur la Grande Kuriate

REFERENCES

ARGANO R., (1979). Preliminary report on western Mediterranean sea Turtles. WWF Project N°1474 : 19 p.

LAURENT L., NOUIRA S., JEUDY DE GRISSAC A. & BRADAI M.N., (1990). Les tortues marines de Tunisie; premières données. *Bull. Soc. Herp. Fr.*, 53 : 1-17.

V

IMPACT DE LA PÊCHE SUR LA TORTUE MARINE *CARETTA CARETTA* SUR LES CÔTES SUD-EST DE LA TUNISIE

Mohamed Nejmeddine BRADAI

Institut National Scientifique et Technique d'Océanographie et de Pêche, Sfax, Tunisie

En Tunisie, et principalement dans le golfe de Gabès *sensu lato*, l'impact de la pêche au chalut benthique sur la population de *Caretta caretta* a été en grande partie élucidé et quantifié (LAURENT *et al.*, 1990 et BRADAI M.N., 1992). Celui des autres types de pêche pratiqués en Tunisie est pratiquement inconnu. Dans ce travail, soutenu financièrement par le RAC/SPA, nous avons essayé de mesurer l'impact de l'essentiel des engins utilisés, autre que le chalutage, sur la caouanne le long des côtes sud-est du pays.

Pour mesurer l'impact de la pêche artisale ou côtière sur la capture de la caouanne *Caretta caretta*, nous avons mené principalement des enquêtes auprés de 149 marins pêcheurs et patrons de pêche ayant au moins 10 années d'expérience et ce, dans environ 20 ports et petits centres de débarquement, de Ras-Dimas à la frontière tuniso-lybienne. Les différents types de pêche pris principalement en considération dans cette étude sont la pêche aux filets (trémail, dérivant de surface, monofilament et filets à crevette), les sennes tournantes, la pêche au thon, la pêche aux feux (lamparos), la palangre flottante et de fond.

Nous n'avons pris en considération dans cette étude que les barques côtières motorisées, les voiliers ayant, à cause de leur faible champ d'action, un impact négligeable sur les tortues marines. L'essentiel des barques côtières motorisées, généralement de 30 à 45 CV, travaillent pratiquement avec tous les engins possibles. Selon notre enquête et nos discussions avec les responsables régionaux de la pêche, nous avons essayé de répartir ce type de barques en barques travaillant principalement aux filets et aux pièges à poulpes (B.F), en petits senneurs (SEN), en palangriers de fond (P.F.D.) travaillant toute l'année ou une bonne partie de l'année aux hameçons de fond, en espadonniers qui participent régulièrement à la campagne et nous avons estimé le nombre des barques utilisants les mini-chaluts (M.CH.) interdits par la législation en vigueur (tableau 1) :

Tableau 1 : Répartition de la flotille dans la région d'étude. LAM. : lamparos ; THN. : thonniers.

Total des barques de la région	B.F	SEN	M. CH	LAM	THN	P. FD	ESP
	2 913	157	153	78	59	96	37

Il n'y a pas de pêche intentionnelles de tortues marines en Tunisie, les captures réalisées sont accidentelles. Si on ne tient pas compte des mini-chaluts, peu étudiés, les barques, surtout celles de fond réalisent le plus grand nombre de captures et re-captures. En effet, un palangrier de fond capture en moyenne 22,83 tortues par an et un espadonnier 12,56 tortues alors qu'un chalutier ne réalise que 6 à 8 captures par an. Les captures et re-captures par chalutage benthique dans le golfe de Gabès ont été estimées en effet à 2 000-2 500 caouannes par an pour une flotille chalutière d'environ 300 unités (BRADAI, 1992). Les autres moyennes de capture sont de 4,17 pour les senneurs, 0,33 pour les lamparos, 1,67 pour les thonniers et environ 2 tortues par an et par barque à filets.

Plusieurs autres engins entraînent des captures de tortues : les mini-chaluts (ou tartaronnes) et les filets à requins. A Sfax, nous avons interrogé 4 patrons de "mini-chalutiers", les captures vont de 3-4 à plus de 100 caouannes par bateau et par an. Ces mini-chaluts pourraient capturer plusieurs centaines, voire quelques millliers d'individus chaque année, mais vu notre faible échantillonnage, nous ne pouvons pas avancer d'estimations. Plus au Sud, à Houmt-Souk, Zarzis et ElKetef, une vingtaine de barques utilisent les filets à requin de fin mars à fin juin. Les captures annuelles par barques varient, selon les ports, de 1 à 30.

Les captures et re-captures annuelles engendrées par les palangriers, les barques à filets, les senneurs, les lamparos et les thonniers s'élèvent à 5 000 caouannes dans la région sud-est du pays. Tous les engins de pêche réunis pourraient engendrer dans les 10 000 captures et re-captures annuellement.

A part les filets trémail, les hameçons de fond et les filets à requin qui provoquent une faible mortalité, les autres techniques de pêche étudiées ne tuent pas les tortues marines. Les tortues capturées, sauf rares exceptions, sont donc vivantes quand elles sont ramenées sur le pont et sont capables de reprendre normalement leur vie aquatique une fois remises à l'eau.

L'observation très fréquente des caouannes en mer au printemps et en été, les captures aux palangres estimées à plus de 2 000 tortues réalisées principalement en cette période de l'année, prouvent que cette espèce est présente toute l'année dans la région du golfe de Gabès. Les chalutiers n'en capturent qu'en hiver lorsque les tortues sont plus rattachées au fond. Des tortues marquées en Grèce sont observées même en été dans cette région.

REFERENCES

LAURENT L., NOUIRA S., JEUDY DE GRISSAC A. & BRADAI M.N., 1990. Les tortues marines de Tunisie, premières données. *Bull. Soc. Herp. Fr.*, 53 : 1-17.

BRADAI M.N., 1992. Les captures accidentelles de *Caretta caretta* au chalut benthique dans le golfe de Gabès. *Rapp. Comm. int. Mer Médit.*, 33.

THE LOGGERHEAD *CARETTA CARETTA* (LINNAEUS, 1758) PELAGIC MOVEMENTS THROUGH THE GIBRALTAR STRAIT

Juan A. CAMIÑAS

Centro Oceanográfico de Málaga. IEO Apdo. 285 29640 Fuengirola, Spain

The swordfish (*X. gladius L.*) fishery program of the IEO during the period 1989-90 followed the activity of vessels working with surface drifting gear off the Atlantic and Mediterranean waters of the Gibraltar Strait (DE LA SERNA, ALOT, 1990a). The surface drift gillnet fishing activity has been practiced on a seasonal basis since the seventies up to the beginning of the nineties. During the first years, this fishery was directed towards small tuna fish that were captured seasonally in areas close to the Moroccan coasts. Subsequently, the vessels had to leave these coastal fishing grounds and began the swordfish fishery after the necessary gear conversion. Drift net fishing (DE LA SERNA, ALOT, 1990b) was developed in an Atlantic area delimited to the south by the parallel 35° N and to the west by the meridian 07° W. It was later extended to the Alborán Sea, and subsequently prohibited by the Spanish Fisheries Administration in 1990. According to DE LA SERNA and ALOT (1990a) this fishery initiated the season in May. The principal swordfish catch stretched to the first part of July and the fish always got meshed in an E-W direction. The fleet newly commenced the fishery in August which could occasionally last to November. During this period, the direction of fish captured changed to W-E. Hence, from May to June, swordfish migrates towards the Mediterranean and inversely during August to November. This fleet accidentally catches the loggerhead turtle (*Caretta caretta*) and in lesser quantities the leatherback turtle (*Dermochelys coriacea*). This paper presents the observations and loggerhead catch by the aforementioned fleet during inspection embarkments carried out during 1989, 1990 and 1993. The turtles were released undamaged.

Five embarkments were done during May, June and August of 1989 and May, off the Gibraltar Strait area with the purpose of acquiring information of fishery technology, captured species, marine environment and its associated catch, such as, turtles and cetaceans (DE LA SERNA and ALOT, 1990b). During May and August 1990, a total of 4 and 7 embarkment days were carried out on board the drifting gillnet fishing vessels. These were done off the Alboran Sea and its immediate Atlantic waters indistinctly, in function of the months and following swordfish migration. In 1993, some embarkments were carried out by researchers from the University of Barcelona in the same kind of vessels (com. pers.). The first ones were done in Mediterranean waters of the Gibraltar Strait in July. The following ones were done in the same area during the first days of August. Swordfish size and weight sampling was conducted. Additionally, information on catch and effort fishing trip, catch situations and complementary environmental data, such as surface temperature, lunar phase, current direction, etc., was acquired.

A total of 38 loggerhead turtles (*Caretta caretta*) have been analyzed once captured by the gillnets; 16 of them were caught off the Atlantic side of the Gibraltar Strait, whereas 22 were caught off the Mediterranean side. During May and June, turtles only got meshed in the Atlantic in a W-E direction. A total of 9 turtles were captured during the inspection embarkments of these months. In the month of July, only 2 turtles were captured, both from the Mediterranean waters nearby the Gibraltar Strait. Observers report that these were meshed in an E-W direction towards the Atlantic. In August, turtle catch reports were both from the Mediterranean and Atlantic sides of the Strait. Nevertheless, they all got meshed in an E-W direction coming out of the Mediterranean. The greatest number of observations occurred during this period : 7 in the Atlantic and 20 in the Mediterranean.

The available information evidence turtle migration into the Mediterranean and inversely, in the opposite direction depending on the season. The Mediterranean entries occur in the preceding months to July, thereby, during the first semester. According to data from the Western Mediterranean surface longline fishery (CAMIÑAS, DE LA SERNA and ALOT, 1992 and CAMIÑAS *et al.*, 1993), during summer, the loggerhead western Mediterranean population migrates in an eastward direction, mainly along the Algerian coasts. This migration route originates from a Balearic resident population and from another group of Atlantic origin, as evidenced from the observations included in this paper. During July and August, a very important migration towards the Atlantic takes place, as the number of observed individuals show. Previous data from the surface longline fishery of the area indicated a migration towards the Alborán Sea of the western Mediterranean population during summer and autumn. The provided data not only corroborates this migration route, but also its exit through the Gibraltar Strait of numerous loggerheads. According to the gathered data from the mentioned longline fishery, this exit could be much more important during September and October, but there is no available information from inspection embarkments to sustain this, but as before commented, the swordfish fishery can last till November. The results presented confirm those of LAURENT *et al.* (1993), based on the distribution of genetic characters of the Atlantic and Mediterranean populations, among other studies (LAURENT, 1990; ARGANO *et al.* 1992; BOLTEN *et al.*, 1992) which include information on catch and recaptures of tagged specimens off the Atlantic and Mediterranean oceans.

REFERENCES

ARGANO, R.; R. BASSO; M. COCCO; G. GEROSA, 1992.- New data on loggerhead (*Caretta caretta*) movements within Mediterranean. *Boll. Mens. Inst. bid. Univ. Genova*, 56-57 : 137-163,1990-1991.

BOLTEN A.; H. MARTINS; K.A. BJORNAL; M. COCCO; G. GEROSA, 1992.- *Caretta caretta* (Loggerhead) pelagic movement and growth. *Herpeto. Review* 23(4).

CAMIÑAS, J.A.; J.M. DE LA SERNA y E. ALOT, 1992.- Loggerhead (*Caretta caretta*) frecuency observed in the spanish surface long-line fishery in the western Mediterrancan Sea during 1989. *Rapp. Comm. int. Mer Médit.*, 33.

CAMIÑAS, J.A.; J.M. DE LA SERNA; E. ALOT, J. ROMERO & M. GONZALEZ.- The loggerhead (*Caretta caretta* L.) distribution in western Mediterranean from captures by the spanish long line fishery. 7th Ordinary General Meeting. S.E.H. Barcelona, 15-19 September, 1993.

DE LA SERNA, J.M. y E. ALOT, 1990 a).- Consideraciones relativas a los desplazamientos efectuados por el pez espada (*Xiphias gladius*) en el área del Estrecho de Gibraltar y otras observaciones relacionadas con la biología de la reproducción. ICCAT. Col. Doc. Cient. Vol. XXXII (2).

DE LA SERNA, J.M. y E. ALOT, 1990 b).- Pesquerías de pez espada con artes de superficie y enmalle a la deriva (mimeo) IEO. Mayo 1990.

LAURENT, L.; J. LESCURE; L. EXCOFFIER; B. BOWEN; M. DOMINGO; M. HADJICHRISTOPHORUS; L. KARNARAKI; G. TRABUCHET, 1993.- Etude génétique des relations entre les populations méditerranéenne et atlantique d'une tortue marine (*Caretta caretta*) à l'aide d'un marqueur mitochondrial. C.R. Acad. Sci. Paris, 316 (10) : 1233-9.

LAURENT, L. 1990.- L'origine des tortues Caouanne, *Caretta caretta* (Linnaeus, 1758) de Méditerranée occidentale. *Rapp. Comm. int. Mer Médit*, 32, 1

V

LENGTH DISTRIBUTION AND MORTALITY RATES OF *MULLUS SURMULETUS* EXPLOITED BY TRAWLING FLEET OFF THE MALLORCA ISLAND

A. CARBONELL, E. MASSUTÍ, O. REÑONES and P. OLIVER

Centro Oceanográfico de Baleares, Apdo. 291, 07080 Palma de Mallorca, Spain

Among other species, the red mullet (*Mullus surmuletus*, L. 1758) constitutes one of the main target species in the multispecific demersal fishery off Majorca. Due to its abundance and economic value, this paper describes the exploitation pattern of this species, developed by the trawling fleet on fishing grounds off south the Island, between 35 and 100 meters depth. The annual mean lenght frequency distributions of the catches for the period 1990–1992 were obtained from the monthly lenght sampling, carried out on the trawling fleet landings. These length distributions were used in order to estimate the instantaneous rate of total mortality by means of transforming the length frequency distributions in a length converted catch curve according to follows methodologies (PAULY, 1984), (BEVERTON & HOLT 1956) and finally by (WETHERAL *et al.*, 1987). Previously, the von Bertalanffy growth parameters and first maturity were estimated by (REÑONES *et al.*, submitted). Natural mortality rates were estimated according to (PAULY, 1979) assuming an average water temperature of 15.5° C (VIVES, 1989) and by TAYLOR (1958). Annual landings between 1990–1992 have remained at a similar level. In this period, annual catches obtained from official statistics were 125, 138 and 127 tons, respectively. Although the red mullet was also fished by trammel nets, the captures of trawl fleet constituted more than 90%. Recently studies carried out in the Western Mediterranean show that the range size is similar for both trawl an trammel nets, but the larger specimens are captured more frequently by trammel nets. The rates of mortality are ligthly underestimated for the larger specimens, as the number of larger specimens in the catches of both gears is little, and the length frequency distributions show that the majority of specimens captured corresponds to the small sizes (more captured with trawls nets) with a range comprised between 10 to 22 cm. In this paper, we consider only the mortality caused by trawl nets. Similarly, the range of exploited sizes during 1990–92 has not changed significatively (Fig. 1), and was comprised between 10 to 32 cm for females and 10 to 28 cm for males.

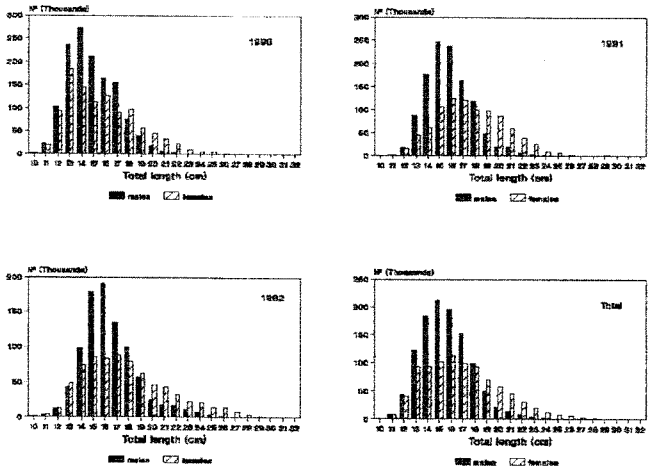


Fig. 1. Length composition of *M. surmuletus*

However, the mean length of catches increased during these years for both sexes as well as the smallest lengths fully recruited represented in the catch samples (l'), which was higher than the first maturity length, that was 15 cm for males and 16.8 for females, both females and males (Table I). Total mortality and natural mortality rate allows to obtain estimation of the fishing mortality rate (F) that was comprised between 0.36–0.44 for females, between 0.46–0.66 for males and between 0.42–0.48 for total population. On the other hand, the exploitation rate (E) was about 0.43 for both, females and males, and 0.46 for all the population (Table II). That all suggested the exploitation was near the optimum and relatively high, and the exploitation pattern is driven mainly towards the smallest lengths.

	l_{min}	l_{mean}	l_{max}	l'
FEMALES	10	19.627	32	16.5
MALES	10	17.525	28	15.5
TOTAL	11	19.035	32	16.5

Table 1. ^{1}mean length mean estimated from 1' smallest length fully recruitment.

	Z^{*}	Z^{**}	Z^{***}	M^{*}	M^{**}	E
FEMALES	0.829	0.805	0.785	0.473	0.384	0.429
MALES	1.072	1.072	1.521	0.607	0.408	0.434
TOTAL	0.903	1.015	1.414	0.483	0.426	0.465

Table 2. Z* from the Catch Curve; Z** from BEVERTON & HOLT; Z*** from WETHERALL *et al.*; M* from PAULY; M** from TAYLOR; E rate of exploitation from Z of Catch Curve.

REFERENCES

BEVERTON R.J.H. & HOLT S.J., 1956. A review of methods for estimation mortality rates in exploited fish populations (...). Rapp. Conseil Explor. Mer, 140 (1) : 67–83.

GAYANILO F.C.,SORIANO Jr M., & PAULY D., 1988. A draft guide to the compleat ELEFAN. Software 2, 65 p. ICLARM, Manila, Filipines.

PAULY, D. 1980. On the interrelationship between natural mortality growth parameters and environmental temperature in 175 fish stocks. *J. Cons. Int. Explor. Mer*, 39:175–192.

TAYLOR C. 1958. Natural mortality rate of Georges Bank haddock. *U.S. Fish. Wildl. Serv. Fish. Bull.*, 58: 1–7.

VIVES F.,1989. Oceanografia y explotación pesquera en el Archipielago Balear. Informe final 243 pp. (mimeo).

DONNÉES PRÉLIMINAIRES SUR LA REPRODUCTION DE *POMADASYS INCISUS* (BOWDICH, 1825, PISCES, HAEMULIDAE) DU GOLFE DE TUNIS

Nadia CHAKROUN-MARZOUK et Mohamed-Hédi KTARI

Laboratoire de biologie marine, Faculté des Sciences, Campus universitaire, 1060 Tunis-Belvédère, Tunisie

Les résultats rapportés ci-dessous concernent la proportion numérique des sexes, la taille de première maturité et le cycle sexuel de *Pomadasys incisus*. Cette espèce est pêchée à l'aide de filets et de lignes à main dans les eaux côtières du golfe de Tunis. 882 poissons, de longueur à la fourche variant de 10 à 22 cm, ont été collectés durant la période 1991-1993 pour cette étude, .

Proportion numérique des sexes. Elle est calculée sans tenir compte des 115 poissons dont le sexe n'a pas pu être déterminé à l'œil nu, de taille comprise entre 10 et 20 cm. Sur 767 poissons, 615 sont des femelles et 152 des mâles, soit respectivement 80,18% et 19,82%; la dominance des mâles par les femelles est statistiquement significative. L'évolution des proportions numériques des sexes en fonction du temps (Fig.1) montre que les mâles rares en hiver sont plus abondants à l'approche de l'été et que c'est le contraire pour les femelles. Cependant quelle que soit la période de l'année, le nombre de femelles est toujours significative-ment plus élevé que celui des mâles. L'évolution des proportions numériques des sexes en fonction de la longueur à la fourche (Fig.2) indique que la fréquence des mâles diminue au profit de celle des femelles avec l'augmentation de taille; au-delà de 20 cm, nous n'avons récolté que quelques rares femelles. Néanmoins, le sexe-ratio diffère significativement au risque de 5% pour toutes les classes de taille et les femelles sont ainsi toujours numériquement plus importantes que les mâles.

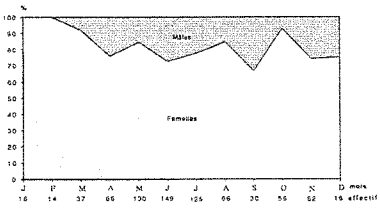


Fig. 1 : variations des proportions numériques des sexes de *P. Incisus* en fonction du temps

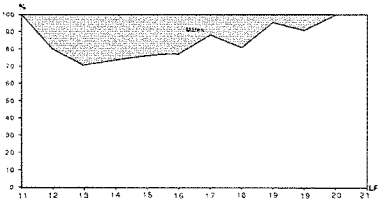


Fig. 2 : variations des proportions numériques des sexes de *P. incisus* en fonction de la longueur à la fourche (LF en cm)

Taille de première maturité sexuelle. L'évaluation par classe de taille du pourcentage d'individus mûrs et immatures, durant la période de reproduction (juillet-août-septembre) montre que les plus petits mâles et femelles mûrs mesurent 14 cm de longueur à la fourche; les plus grands mâles et femelles immatures le sont à 17 cm. La taille à laquelle 50% des femelles sont adultes est égale à 14,1 cm (contre 14,5 cm pour les mâles) et celle à laquelle 100% des poissons le sont est de 18,4 cm (contre 18,7 cm pour les mâles).

Cycle sexuel. Le rapport gonado-somatique (RGS) des femelles, calculé pour les individus dont la classe de taille est d'au moins 15 cm, s'élève rapidement à partir de mai pour atteindre son maximum en juillet (phase de maturation); il reste presque stable au mois d'août, puis diminue brutalement jusqu'en octobre (période de ponte). La période de repos sexuel s'étend de novembre à avril. Le rapport hépatosomatique (RHS) des femelles commence à croître dès le mois d'avril et atteint son maximum en juin alors que le RGS est encore relativement faible; il commence à diminuer légèrement en juillet, puis brutalement en août alors que le RGS atteint ses valeurs les plus élevées. Ce rapport présente, en outre, deux sommets secondaires, l'un en novembre, l'autre en mars. Le coefficient de condition (Kc) évolue de la même manière que le RHS; les femelles présentent un maximum d'embonpoint d'avril à juillet et s'amaigrissent au moment de la ponte en août-septembre (Fig.3). Le RGS des mâles suit une évolution cyclique analogue à celle des femelles, cependant l'amplitude moyenne du RGS est plus élevée chez les femelles (0,5 à 4,3) que chez les mâles (0,12 à 3,25). Le RHS des mâles augmente d'avril à juin et s'abaisse en juillet, quand le RGS est à son maximum, pour attein-dre un minimum en août. La condition des mâles semble moins affectée par la reproduction puisque le facteur Kc continue à s'élever graduellement durant la période de reproduction (Fig.4).

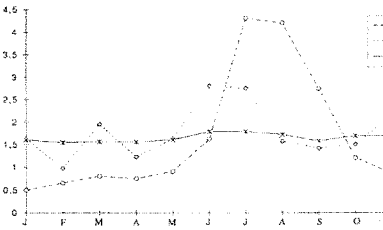


Fig. 3 : évolution mensuelle de RGS, RHS et Kc des femelles de *P. incisus*

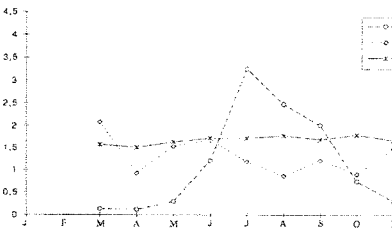


Fig. 4 : évolution mensuelle de RGS, RHS et Kc des mâles de *P. incisus*

V

BASE STUDY FOR MONITORING THE RESERVE EFFECT IN THE CABRERA NATIONAL PARK, BALEARIC ISLANDS. AN INDICATOR SPECIES EXAMPLE : *EPINEPHELUS GUAZA* (L.)

J. COLL[2], O. RENONES[1], J. MORANTA[1] and B. MORALES-NIN[2]
[1] Laboratori de Biologia Marina (U.I.B), 07071 Palma de Mallorca, Spain
[2] CSIC-IEA, Campus universitario, 07071 Palma de Mallorca, Spain

During the summer 1993, two years after the establishment of the Cabrera National Park, a survey of principal fishery species was conducted using visual methods. Here we present the results obtained for the density and sizes distribution of *E. guaza*. The biological and ethological features of this species, together with the irregularity of its recruitment, north of latitude 41°5N (CHAUVET & FRANCOUR, 1990; GARCIA & ZABALA, 1994) and its high commercial value, have caused the stocks of *E. guaza* to decline notably in several parts of the Mediterranean.

In Balearic waters where the species shows a high recruitment, the fishing pressure has been reflected in the scarcity of adult individuals. At present, the artesanal fishery is the only way of exploitation permitted around Cabrera. The selection of sampling zones has been based on the different regulations which will be enforced on the artesanal fisheries once the management for the park will be operational.

The following sampling stations have been studied : 3 stations on rocky blocks at 5-10 and 20-25 m depth (photophilic algae benthic community : P.A), 2 stations on vertical underwater cliffs at 5 and 15 m (P.A), 2 stations on rocky blocks at 40 m (sciaphilic algae benthic community) and 1 station on *Posidonia oceanica* meadow.

Censuses were carried out over transects 100-210 m long and 10 m width. Daily censuses were made for at least 6 consecutive days between 10.00 and 14.00 hours. In each transect, the number of individuals observed was noted and their size estimated. All divers had been previously trained in estimating fish size underwater using a method similar to that of BELL *et al.* (1985).

The greatest density of groupers was found at stations 5-10 and 20-25 m depth at zone 3 (Table 1). The richness of this zone, verified by the abundance of other species, can be linked to three principal factors: a) site exposed to all winds, b) high degree of complexity of bottom structure, and c) constant currents which may increase the production at different trophic levels. No groupers were observed at the stations on rocky blocks at 40 m depth or in *Posidonia oceanica* meadow.

Another notable feature is the segregation of small and large sizes in shallow and deep waters respectively (Fig. 2). The nature of these differences is probably due to two main factors: a) the recruitment occurrs in the first few metres depth, b) before 1991, the Cabrera area was intensively fished, especially by spearfishing. This kind of fishing is known to be depth selective. Bottoms at 5-10 m are more accessible than those at 20-25 m. Natural bathymetric distribution of *E. guaza* (CHAUVET, 1991) and results from other reserves (GARCIA & ZABALA, 1994) indicate that shallow waters of Cabrera have not been yet recolonized by big groupers.

Transects/Statistics	Mean	C.L. 95%	C.V
Zone 1. Blocks: 5-10m	6,24	(5,23-7,41)	17%
Zone 1. Blocks: 20-25m	3,57	(2,63-4,75)	27,8%
Zone 2. Blocks: 5-10m	4,21	(3,05-5,68)	35,45%
Zone 2. Blocks: 20-25m	0,97	(0,38-1,83)	53,33%
Zone 3. Blocks: 5-10m	7,17	(4,75-9,91)	33,93
Zone 3. Blocks: 20-25m	6,17	(4,15-9,07)	32,15%
Zone 2. Cliffs: 5m (0-10)	1,76	(1,09-2,43)	36,36%
Zone 2. Cliffs: 15m (10-20)	0,78	(0,14-1,42)	78,2%
Zone 3. Cliffs: 15m (10-20)	1,9	(0,41-3,38)	62,63%

Table 1. Mean density of *E. guaza*, 95% comfidence limits and coefficient of variation for a surveyed area of 1000 m².

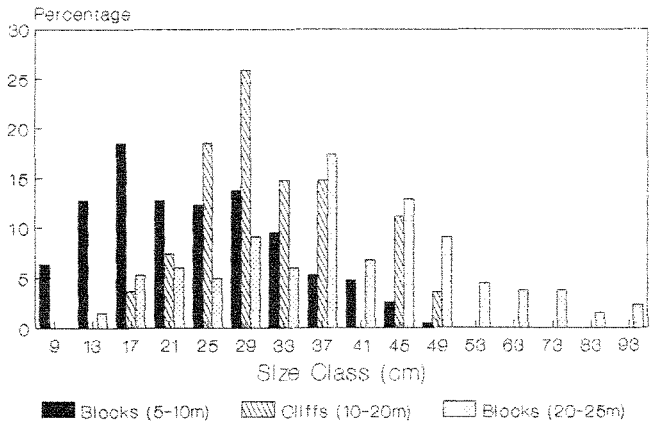


Figure 1. Sizes distribution of *Epinephelus guaza*.

REFERENCES

BELL *et al.* 1985. *Coral Reefs* (4 : 41-44.
CHAUVET C. & FRANCOUR P. 1990. *Bull. Soc. Zool. France*,114 (4) : 5-13.
CHAUVET C. 1991. *In* "Les espèces marines à protéger en Méditerrannée" GIS Posidonie publ. Fr : 255-275.
GARCIA-RUBIES A. & ZABALA M., 1994. *In* "Seguiment temporal de les Illes Medes. Informe Técnic per al Departament d'Agricultura Ramaderia i Pesca, Generalitat de Catalunya".

INDIVIDUAL ESTIMATES OF RNA/DNA RATIOS OF ANCHOVY LARVAE (*ENGRAULIS ENCRASICOLUS*) OF THE NORTHWESTERN MEDITERRANEAN (CATALAN SEA AND GULF OF LIONS)

D. CORTÉS[1] and T. RAMIREZ[2]
[1] I.E.O. Centro Oceanográfico de Málaga, 29640 Fuengirola, Spain
[2] Departamento de Quimica Inorgánica, Universidad de Málaga, Spain

The survival of young fish is conditioned to several factors; namely, predation, inanition and hydrographic entrainment to unfavourable areas, or through an interaction of several of these factors. Larvae under starving conditions are more vulnerable to predation (PURCELL *et al.*, 1987). Therefore, the nutritional state of fish larvae must play a key role in understanding recruitment variability. The use of RNA/DNA indices for studying larval condition in fish larvae is justified, taking in account that the total amount of desoxy-ribonucleic acid (DNA), per cell must be constant in individuals of the same species, and that it does not vary apparently with starvation or with environmental factors. However, the amount of ribonucleic acid (RNA) present in the cell is variable, because it is directly related to protein synthesis. Thus, RNA/DNA ratios is an index of the metabolic rate of the cell. Larvae under starving condition present lower RNA/DNA indices than well-fed larvae; decreasing linearly during periods of inanition (BUCKLEY, 1980; CLEMMESSEN, 1988).

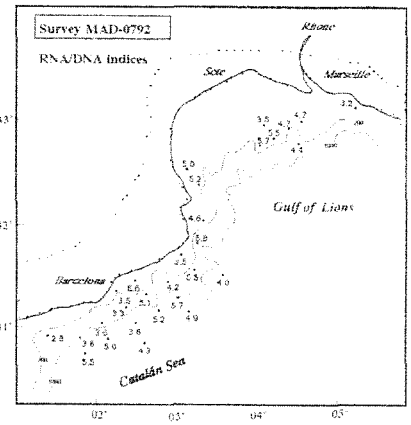
RNA/DNA ratios have been used for the first time, on individual larvae of anchovy (*Engraulis encrasicolus*), sampled in the northwestern Mediterranean Sea. RNA/DNA indices of 191 anchovy larvae from 28 stations, distributed between the Catalán Sea and Gulf of Lions were estimated (between the meridians 1°E and 6°E). The size length distribution of the analized larvae varied between 6 and 12 mm. The individual indices RNA/DNA varied between 1 and 7.8. The samples were collected during the anchovy egg and larval survey "MAD-0792", on board the R/V Garcia del Cid, during 27/6/92-26/7/92. Anchovy larvae were collected by Bongo 40 mouth opening plankton nets equipped with 200 µm. The RNA/DNA indices have been determined by measurements of fluorescence, using specific nucleic acid fluorescent dyes. Ethidium bromide was employed for the joint determination of the RNA and DNA, while the bisbenzimidazole was used exclusively for the determination of RNA following the method described by CLEMMESSEN (1988) with some modifications described in CORTÈS & RAMIREZ (1994). Larvae were sorted quickly from the plankton collectors and only the well conserved and good condition ones were destined to RNA/DNA analysis. These were measured on board through micronmetric eyepieces fitted on stereoscopic microscopes, set permanently at 10 X magnitude. Immediately after measurement these were stored in liquid nitrogen. The chemical reactants used in the extraction of nucleic acids and the analytical procedures are in the following table.

Tris buffer, pH=8.8	Chloroform/isoamylalcohol 24:1
Tris 0.5 M, pH=8	Ethidium bromide
Proteinase K	Bisbenzimadazol
SDS 20%	DNA standard (calf thymus)
Saturated phenol (pH=8)	RNA standard (yeast)

An ultrasonic generator Branson Sonifer 250 was used to homogenize the larvae. Fluorescence measurements were done with a Perkin Elmer LS-5 spectrofluorometer equipped with a data processing system, the Perkin Elmer 3600 Data station. For absorbance measurements in UV at 260 nm, the spectrophotometer Perkin Elmer mod. Coleman 55 was used. The maximum emission for DNA/RNA-EB is located at 589 nm for a wave length of excitation at 324 nm. The latter differs from that proposed by CLEMMESEN (1988). For DNA-Bis, the maximum emission is located at 447 nm for a wave length of excitation at 352 nm. The data for building the calibration curves were fit to a linear functions with the results as shown in the joint table.

DNA-Bis	y= 0.65354 + 33.733x	R = 0.99
DNA-EN	y = 1.033 + 31.044x	R = 0.99
RNA-EB	y = 0.029603 + 11.108x	R = 0.99

The total quantity of DNA is an index of the number of cells. This is assumed to be independent of environmental factors. The DNA content is aproximately constant for larvae of practically the same size. However, RNA values present variations, since these are dependent of the metabolic rate of cells. Nucleic acid content (DNA, RNA) varied exponentially with size. No differences have been observed in DNA content from larvae sampled in the Catalán Sea and Gulf of Lions. High RNA/DNA ratios (> 6) seem to related with the existing larval abundances (larvae/m²), differentiating the two areas studied. In the Catalán Sea, high values of RNA/DNA ratios (> 6) are associated with areas where larval abundances are in the range of 0 to 40 larvae/m². In the Gulf of Lions these high values (> 6), correspond to the abundances range 0 to 140 larvae/m². The stations with maximum values of RNA/DNA indices seem to be associated to the Ligur-Provençal-Catalán front. This front has some permanent hydrographic features (FONT *et al.*, 1988). Related with this front, maximum zooplankton abundances have been observed by (SABATÈS *et al.*, 1989), even when compared to the coastal areas. During summer, PALOMERA (1992) also found anchovy spawning grounds associated to this front. RNA/DNA ratios between 4.5 and 5.5 in the Catalán Sea are found in areas close to the slope, while in the Gulf of Lions these are in the shelf border (Fig. 1).



Spatial distribution of mean RNA/DNA indices by station

This study was realised with financial aid from the Commission of the European Communities.

REFERENCES

Buckley, L. J., 1980. *Fish. Bull.* 77 : 703-708.
CLEMMESEN, C. M., 1988. *Meeresforsch* 32 : 134-143.
CORTÈS, D. and RAMIREZ, T., 1994. Final Report Study Contract FAR Proyect MA 3.730. U.E. DG XIV.
FONT, J., SALAT, J. and TINTORE, J., 1988. *Oceanol. Acta*, vol. sp. 9 : 51-57.
PALOMERA, I., 1992. *Mar. Ecol. Prog. Ser.* 79: 215-223.
PURCELL, J. E., SIFERD, T. D. and MARLIAVE, J. B., 1987.*Aequorea Victoria. Mar. Biol.* 94: 157-162.
SABATES A., GILI J. and PAGES F., 1989. *Mar. Biol.* 103 : 153-159.

GROWTH DYNAMICS OF SPRAT *SPRATTUS SPRATTUS* L. OFF BULGARIAN BLACK SEA COAST

Gueorgui DASKALOV

Institute of Fisheries, Varna, Bulgaria

Sprat shows remarkable variability in size and growth rate between years and this feature creates its specific adaptive response to changes in environment. In this study we analyse the growth of cohorts 1977 to 1990 in relation to some environmental and population characteristics. Growth was modelled on the base of monthly length-at-age data by fitting the von Bertalanffy growth function (VBGF). Growth performance index : $\phi' = \log 10k + 2\log_{10}Loo$ 1) (PAULY and MUNRO, 1984) together with direct length-at-age observations were used for growth comparisons. Correlation analysis was performed on growth parameters and environmental indices (Table 1.)

Table 1. Correlation matrix of growth and environmental parameters: ϕ'-growth performance; L1,L2-length-at-age 1 and 2 years; L-mean length; ΔL1,ΔL2-annual increment at age 1 and 2; c.f.-condition factor; R-recruitment; N1+,B1+-stock numbers and biomass at age 1 and older; F-fishing mortality; S.I.-spawning intensity[1]; Zoo, Ph-zoo- and phytoplancton biomass; PO4, To, C.W.- phosphate concentration, water tempeture and winter cold[2] in the N-W Black Sea. Significance levels: *- p = 0.05; # - p = 0.01

	year	ϕ'	L1	L2	L	ΔL1	ΔL2	c.f.	R	N1+	B1+	F	S.I.	Zoo	Ph	PO_4	T°
ϕ'	0.09																
L1	-0.91#	-0.27															
L2	-0.87#	0.16	0.77#														
L	-0.88#	0.15	0.78#	1.00#													
ΔL1	0.52	0.79#	-0.73#	-0.28	-0.31												
ΔL2	0.71#	0.04	-0.82#	-0.69#	-0.72#	0.55*											
c.f.	-0.22	0.53	0.27	0.34	0.34	0.30	-0.51										
R	-0.67#	-0.09	0.68#	0.43	0.45	-0.56*	-0.65*	0.03									
N1+	0.83#	-0.48	0.84#	0.66*	0.68#	-0.76#	-0.56*	-0.37	0.52								
B1+	-0.91#	-0.33	0.88#	0.70#	0.73#	-0.70#	-0.67#	-0.19	0.62*	0.97#							
F	-0.02	0.52	-0.15	0.22	0.18	0.55*	0.25	0.66*	-0.10	-0.36	-0.32						
S.I.	0.43	0.79*	-0.44	0.03	-0.02	0.70*	0.23	0.65	-0.43	-0.73*	-0.67*	0.69*					
Zoo	-0.75#	-0.08	0.68#	0.83#	0.82#	-0.40	-0.52	0.19	0.30	0.69#	0.68#	0.13	-0.02				
Ph	-0.58*	-0.23	0.41	0.56*	0.58*	-0.36	-0.38	-0.20	0.26	0.58*	0.58*	-0.32	-0.46	0.50			
PO_4	-0.46	-0.39	0.44	0.61*	0.57	-0.35	0.31	-0.22	-0.06	0.38	0.34	0.00	-0.22	0.73#	0.71#		
T°	0.70	0.78*	-0.81*	-0.56	-0.66	0.88#	0.71*	0.14	-0.25	-0.80*	-0.74*	0.70	0.81*	-0.65	-0.50	-0.51	
C.W.	-0.69	-0.77	0.48	0.10	0.13	-0.62	-0.06	-0.45	0.37	0.62	0.54	-0.42	-0.90#	0.24	0.52	0.42	-0.61

1 As a relative index of interannual variability of the spawning intensity was used the average percentage of fishes with ovaries in maturity stages IV and V during the peak spawning season: November - January.

2 Winter conditions are importants because of the positive effect of the winter convection (which is particularly intensive in cold and windy winters) on bioproductivity.

An intensification of sprat fishery started in the mid 70's on the base of rising stock abundance, due to outstanding "eutrophic" productivity of the Black Sea and reduced predatory press. After 1980, sprat biomass being hard exploited, dropped down in Bulgarian waters (PRODANOV and DASKALOV, 1992). In terms of growth, the period 1977-1993 is characterized by decrease in size and relative increase in growth rate till 1987, when growth dramatically drops on the level of 1978 (Table 2, fig.). The relation between length and annual increment is negative; that shows a compensatory effect of growth (L1 vs. ΔL1-R = -0.78 ; L2 vs. ΔL2 - R = -0.69). Significant correlations between growth parameters and abundance estimates show evidence for density-dependent growth. The rate of exploitation expressed by fishing mortality coefficients (F) correlates positively with growth perfor-mance (ϕ'): R= 0.52; annual increment (ΔL1): R = 0.55 and c.f.: R = 0.66. The spawning intensity is negatively related with the abundance and positi-vely related with c.f.: R = 0.65, and with growth rate. The trophic environment, expressed by zoo- and phytoplancton abundance and by phosphate concentration correlates in some degree with size. The last two indices however give very rough image of the trophic conditions because they are relevant to the Northwestern part of the sea. The same is the case with the climate indices (T ° and C.W.), which nevertheless show significant relation with growth within the period 1977-85. This stresses one more time the necessity of more severe analysis of the dependence of the fishery productivity on climate. Although the correlations account for majority of the variation in the analysed time series, they do not indicate direct relationships between them. The changes in growth of sprat can be associated mainly with the graduate reducing of the standing stock under intensive exploitation. After 1986, planctivorous invertebrates (especially the ctenophore *Mnemiopsis* sp.) become dominant in the pelagic community. Competition on food with fish larvae could be one possible explanation of the decrease in growth in the last years.

year	Loo	k	ϕ'	ΔL1	L	c.f.
1977	12.62	0.329	1.719	0.89	10.59	-
1978	30.73	0.042	1.598	0.89	10.13	0.58
1979	14.30	0.271	1.744	1.31	10.17	0.553
1980	16.85	0.145	1.615	1.04	10.67	0.587
1981	12.41	0.594	1.961	1.79	10.40	0.614
1982	12.80	0.427	1.845	1.48	10.23	0.616
1983	13.21	0.344	1.778	1.37	10.10	0.585
1984	12.02	0.544	1.895	1.44	10.27	0.588
1985	13.50	0.282	1.711	1.27	9.80	0.596
1986	12.65	0.404	1.811	1.49	9.80	0.576
1987	26.03	0.069	1.670	1.19	9.27	0.581
1988	19.36	0.129	1.684	1.39	9.57	0.554
1989	15.34	0.230	1.733	1.57	9.06	0.568
1990	12.27	0.399	1.770	1.45	9.10	0.593

Table 2. Growth parameters of sprat

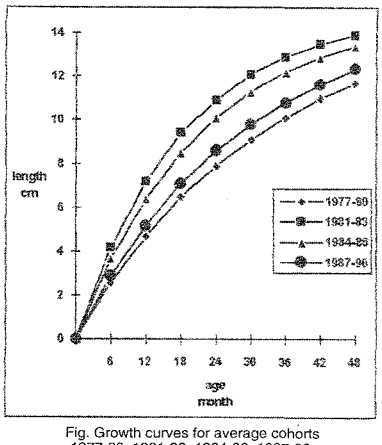


Fig. Growth curves for average cohorts 1977-80, 1981-83, 1984-86, 1987-90.

ACKNOWLEDGEMENTS. the present study was partly supported by the Research Support Scheme of the Central European University, no:182\1041\91-92.

REFERENCES

PAULY, D. and J.L. MUNRO, 1984. *Fishbyte* 2(1) : 21

PRODANOV, K. and G. DASKALOV, 1992. *Rapp. Comm. int. Mer Médit.*,33: 305

STOCK ASSESSMENT OF SPRAT *SPRATTUS SPRATTUS* L. OFF BULGARIAN BLACK SEA COAST, USING LENGTH COHORT ANALYSIS

Gueorgui DASKALOV[1] and Kamen PRODANOV[2]

[1] Institute of Fisheries, Varna, Bulgaria

[2] Institute of Oceanology, Varna, Bulgaria

First attempt is made to evaluate the dynamics of abundance and mortality of sprat stock by means of the Length Cohort Analysis (LCA) (JONES, 1981).

Length composition data for Bulgarian sprat catches was averaged generally by 3 years over the period 1945-92 and the resulting pseudo-cohorts were assumed to be under steady state conditions.

LCA was performed using ANALEN software package (CHEVAILLIER et LAUREC, 1990), where an iterative procedure for running the analysis was employed. It was also possible to estimate the fishing mortality rates per fishing gear for 1970-92, when separated statistics for coastal (trapnets, beach seines) and trawl fisheries were available. Sensitivity analysis was taken into account, for the optimal choice of parameters.

It was not possible to estimate directly the von Bertalanffy's parameters, because of lack of satisfactory data covering all the period studied. Even though such estimates were available for 1977-93 (DASKALOV, this vol.), we did not obtain reasonable results using these values. The procedure suggested by JONES (1990) gives closest results with previous studies (DASKALOV, 1993).

Table. **A** : Parameters used in anlysis. **B** : Basic results.
R= recruitment in 106 numbers, B = mean biomass in tons, F = average fishing mortality rate

	A			B		
years	k(Loo=16)	M	F+	R	B	F
45-49	0.156	1.2	0.014	4449.8	7575.1	0.108
56-59	0.155	1.2	0.026	9877.7	17634.0	0.089
60-62	0.164	1.2	0.013	55244.1	133686.2	0.007
63-65	0.188	1.2	0.011	12224.2	26035.4	0.029
66-68	0.239	1.2	0.006	12998.6	32174.3	0.014
69-71	0.239	1.2	0.014	9354.6	21751.7	0.046
72-74	0.265	1.2	0.024	311150.0	79686.2	0.024
75-77	0.241	0.95	0.041	29197.2	113437.9	0.028
78-80	0.185	0.95	0.088	46438.5	176661.6	0.039
81-83	0.314	0.95	0.06	16373.7	58990.0	0.146
84-86	0.267	0.95	0.04	13682.3	39556.5	0.237
87-89	0.237	0.95	0.028	13553.4	37006.7	0.135
90-92	0.217	0.95	0.009	7766.65	23495.6	0.079

The average value Loo = 16cm (1977-92) was assumed for all the period and then k was found :

$$k = \ln((Loo-l1)/(Loo-l2))$$

where l1 and l2 were respective lengths-at-age 1 and 2 years (Table, A). Terminal length group (+) was chosen to be 12 or 11.5 cm (> 75%Loo). Natural mortality rate was assumed - 0.95 for 1975-92 and 1.2 for 1945-74 – the last one for the purpose of reflecting the higher predation in that period (STOYANOV, 1966, IVANOV and BEVERTON, 1985). Terminal fishing mortality rates were obtained according to DASKALOV's VPA estimates (1993). A functional regression built between catches (C) and fishing mortality rates (F) with coastal gears for 1975-92 was used to determine F+ values before 1975.

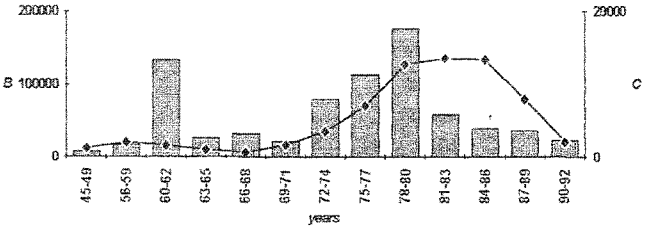


Fig. Sprat mean biomass (B : columns) and catches (C : line) in tons : 1945-92

The evolution of the sprat stock state could be devised into three main stages (Table, B. Fig.). In the years up to mid 70's, stock biomass remains relatively low in relation with a strong predatory press. As an exception, we observe the period 1960-62 where higher abundance is probably resulting from the combination of stable recruitment and favourable environment at the end of 50's. The second stage is characterised by a very strong increase of stock biomass and fishing from mid 70's to mid 80's. Such an "explosion" could be related with the extinction of top predators in late 60's and early 70's, and the rise of the sea trophic level due to progressive eutrophication. The combined action of two factors explains the decrease in sprat biomass after the late 70's. In the beginning, the high nutrient abundance resulted in amelioration of the trophic base, but soon the outstanding eutrophication created different negative effects, like hypoxia and increasing domination of gelatinous megaloplancton, which is feeding on fish eggs and larvae and competes planctivorous fish on food. The second factor is obviously the fishing effort remaining too high at the same time when the standing stock is decreasing.

REFERENCES

CHEVAILLIER, P. et LAUREC, A, 1990. FAO Doc. Tech.Pêches, 101(4) : 124 pp.

DASKALOV, G.1993. Rapport de DEA, Univ. Aix-Marseille II, OSU(COM)

IVANOV, L and BEVERTON, R.S.H., 1985. FAO Stud.Rev., 60 : 135 pp.

JONES, R., 1981, FAO Fish.Circ.,734 : 57 pp.

JONES, R., 1990, *J. Cons. int. Explor. Mer*, 46 : 130-139

STOYANOV, S.,1966, *Izv.Nauchn.Inst.Rib.Stop.Okeanogr.*, Varna, 6 : 21-48

V

PRELIMINARY RESULTS ON THE EFFECTS OF MOBILE FISHING GEAR ON BENTIC HABITAT OFF THE CATALAN COAST

Montserrat DEMESTRE

Institut de Ciències del Mar. P. Joan de Borbó s/n. 08039 Barcelona, Spain

The fishing activity in the Catalan coast uses a variety of mobile gear types. The most common are bottom trawl and dredge. The impact of these harvesting methods may have on fishing stocks and the habitat supporting them is still to be determined. The main objectives of this study are: a) to analyze and compare the effects of the disturbance of these two gears on the benthonic macrofauna, in terms of abundance (n° species caught per taxonomic group, in percentage) and of biomass ($Kg*h^{-1}$), and b) an initial assessment of the survival rates alteration of the animals caught. The data analyzed were collected in two Catalan ports : Sant Carles and Vilanova.

Impact on the benthonic macrofauna. The impact of the bottom trawl on the four main exploited groups, shows slight differences between the results obtained in terms of abundance and those obtained on biomass (Fig.1). The impact of the dredge on the same four taxonomic groups presents very marked differences between abundance and biomass. The results indicate that, while the two gear types catch virtually the same groups of species, the importance of each of them in the total catch differs as a function of the gear considered. This difference between the two gear types is even sharper if we compare the biomass results. In the case of the bottom trawl, fish represent the largest group in both the number of individuals and in biomass. In spite of being one of the targets of bottom trawl fishery, not all of the fish caught are marketed. Part of catch is discarded. The largest group in the dredge landings, particulary where the biomass is concerned, are the molluscs. Of this group, there is a high percentage of the two target species : *Bolinus brandaris*, representing 20.7% of the total catch, and *Chamelea gallina* with 37.16%. The remainder of the catch consists mainly of non-commercial species, which are also discarded.

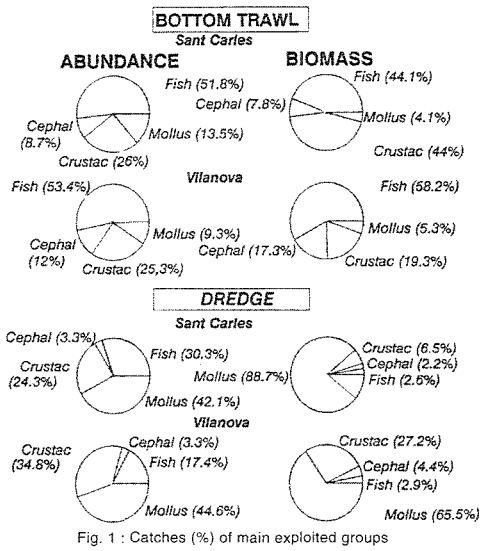


Fig. 1 : Catches (%) of main exploited groups

Surviving the net. The survival rate of the organisms descarded show a wide intra-specific variation. Assessing the by-catch groups of the hauls of dredge by port, in San Carles the most strongly affected are the echinoderms (Fig.2). Of these, the flexible types, such as holoturoids, asteroids and ophiuroids show a net survival rate of practically 90-100%. The sea urchins which are easily smashed and exposed them to predation, has the highest mortality. In Vilanova, the sessile organisms, such as posidonia, are the most disturbed by catch group, in that none of them survive. In biomass, their catch is 11-12 kg/h, the highest value in the entire haul. The tunicates, which are also flexible animals and the second most important group by weight, present a very high net survival rate. In general, the discarded fish caught with bottom trawl exhibit a minimum survival rate, for the majority of the fish are already dead when they reach deck of the boat. In contrast, the general discards of dredge show a very high survival rate, since the great majority are non-commercial molluscs, gasteropods and bivalves. Practically all of them are still alive after they have been caught and put on the deck. There is little evidence of the effect of disturbance due to dredge on the commercial species, like in fish, which are currently exploited with bottom trawl. On the other hand, it was found that this type of gear can have a very negative effect on all the species caught which are not commercial, as is the case with the posidonia and the sea urchins. Furthermore, what must also be considered is the possible benefit that the organisms able to survive the discards may have gained from the effect of the disturbance of mobile gears in the long-term.

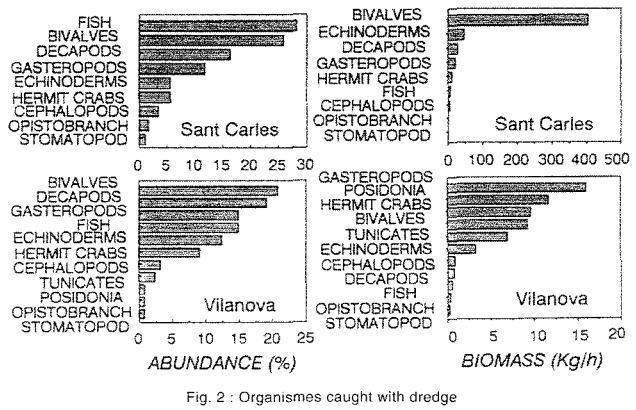


Fig. 2 : Organismes caught with dredge

This study was financed by the Generalitat de Catalunya (contract Ref. PCC 300 12/90).

PARVALBUMIN AND MYOSIN EXPRESSION IN THE TELEOST *DICENTRARCHUS LABRAX* (L.) WHITE MUSCLE DURING DEVELOPMENT

B. FOCANT[1], F. MELOT[1], P. VANDEWALLE[2] and F. HURIAUX[1].

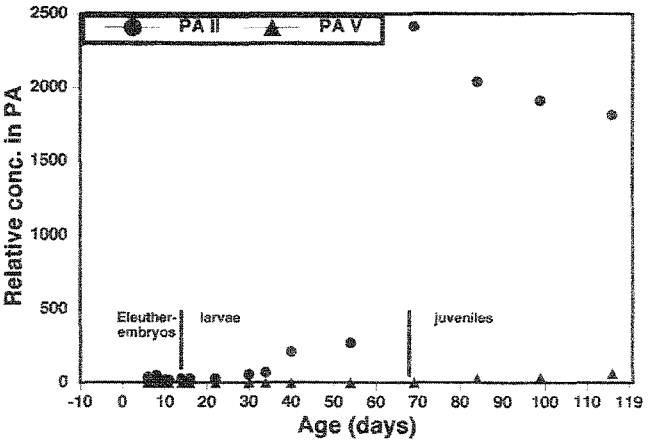
Laboratoires de Biologie cellulaire et tissulaire[1] et de Morphologie fonctionnelle[2], Université de Liège, Belgique

Parvalbumins are Ca^{2+}-binding polymorphic proteins that are abundant in fish white muscle sarcoplasm where they can act as muscle soluble relaxing factor.They are thermostable and display 1 to 5 muscle and species specific isoforms of nearby same low molecular weight (12 KDa). Myosin, the major myofibrillar protein, is a hexameric molecule made of two heavy chains (HC, 200 KDa) and four light chains (LC, 16 to 25 KDa). In terrestrial vertebrates, successive isoforms of HC and LC are expressed during muscle ontogeny.The sequential appearance and disappearance of different isoforms of these proteins in the muscle fibers have been recently observed in various freshwater fishes (FOCANT *et al.*,1992,1994; HURIAUX *et al.*,1994). These isoforms are most probably related to the requirements of the developmental stages of the growing fish.

The sea-bass (*Dicentrarchus labrax* L.) was chosen for this study with in view the availability of the developmental stages of this marine teleost and in order to increase our knowledge on the muscle development of this commercially important species.The specimens (from 3 days before hatching until 115 days post-hatching and adult) were kindly furnished by the "Ecloserie marine SEPIA Exploitation", Montigny-le-Bretonneux, France. Trunk muscle was dissected and muscle fiber membranes were destroyed in a buffered solution containing 50% glycerol.Sarcoplasmic proteins, including parvalbumins, were separated by centrifugation from insoluble myofibrillar material (actomyosin). After heating the sarcoplasmic extract at 80°C for 5 min in order to eliminate most of the proteins, the parvalbumin isoforms [PA II (75%) and PA V (25%) in the adult muscles] were analysed on PAGE in the presence of 10% glycerol at pH 8.6. They were separated according to their negative electric charge; their relative amounts were estimated by densitometry (versus the total sarcoplasmic protein content). The actomyosin complex was dissociated in sodium dodecylsulfate (SDS); the myosin HC and LC were respectively separated on discontinuous high (6% acrylamide, 30% glycerol, pH 8.8) and low (20% acrylamide, pH 8.4) porosity PAGE according to their molecular weight. An unforeseen finding is the very late detection of both parvalbumins and myosin despite the fact that earlier stages contain organized muscle fibers.The sequential apparition of the parvalbumin isoforms (relative amounts of PA II and PA V) during the development is illustrated in the figure.PA II appears first in the 30 days old larvae; its content reaches a maximum at 69 days (transition from larval to juvenile stage) and then slowly decreases. PA II corresponds thus to a "larval" isoform. PA V appears at this 69 days stage and augments very slowly. Myosin HC and LC are not detectable before the age of 40 days.The myosin HC of the larvae cannot be distinguished by their molecular weight from the adult ones. The stoechiometric distribution of the three light chains looks similar to that of adult myosin (LC_1 : 8%, LC_2 : 58%, LC_3 : 34%).

These results are in agreement with the histochemical observations of SCAPOLO *et al.*(1988) showing that myosin ATPase activity cannot be demonstrated in any part of the myotome before 65 days old larvae. According to these authors, the histoimmunological analysis during the different stages of the myotomal development revealed changes in the myosin composition : they suggested the presence of larval forms of myosin (Larval 1 until 28 days and Larval 2 until 20 months), analogous to the embryonic forms found in other vertebrate muscles. These forms without detectable ATPase activity could be very labile, in very low amount or not extracted in our experimental conditions. They histochemically distinguished the definitive adult form by the appearance of characteristic myosin ATPase activity, by 20 months in the trunk muscles. In barbel and trout (FOCANT *et al.*,1992,1994; HURIAUX *et al.*,1994) the "larval" parvalbumin isoform PA II rapidly increased from the hatching. Myosin light chains were also detected very early, the relative proportions of LC_1 and LC_3 quickly changing during the early steps of development. Myosin from embryonic and larval stages contained heavy chain isoforms distinct from adult ones, confirming the existence of different myosins.

Compared with other fish species, the development of the muscle of the sea-bass appears very slow and biochemically less determined. At least in the case of parvalbumins, the polymorphism constitutes a modulating mecanism for speed and power of contraction adapted to the growing fish. Older specimens are now under investigations.



REFERENCES

SCAPOLO P.A., VEGGETTI A., MASCARELLO F. and ROMANELLO M.G.,1988. *Developmental transitions of myosin isoforms and organization of the lateral muscle in the teleost Dicentrarchus labrax* (L.). *Anat. Embryol.*, 178 :287–295.

FOCANT B., HURIAUX F., VANDEWALLE P., CASTELLI M. and GOESSENS G., 1992. Myosin, parvalbumin and myofibril expression in barbel (*Barbus barbus* L.) lateral white muscle during development. *Fish Physiol. Biochem.*, 10:133–143.

FOCANT B., VANDEWALLE P. and HURIAUX F., 1994. Myosin polymorphism during the development of the trout, Oncorhynchus mykiss. *Arch. intern. Physiol. Biochim. Biophys.*, 102:B54.

HURIAUX F., VANDEWALLE P. and FOCANT B., 1994. Temporal and spatial distribution of the parvalbumin isotypes in the trout muscles. *Arch. intern. Physiol. Biochim. Biophys.*, 102:B56.

This work was supported by the FRSM of Belgium, contract N° 3.4514.93. B.F. and P.V. are "Research Associate" of the FNRS of Belgium.

V

CETACEAN SIGHTINGS IN THE ALBORAN SEA. JULY 1993

FRANCO I.[1], MAS J.[2] and RODRIGUEZ C.[2]

[1] IEO. Centro costero de Fuengirola. Ap. C. 285. 29640-Fuengirola, Malaga, España
[2] IEO. Centro Costero de Murcia. Ap. C. 22. 30740 S. P. del Pinatar, Murcia, España

The Mediterranean cetacean populations have in recent years been surveyed by several authors. These surveys have mainly taken place in the sea water around Italy : Ligurian sea (GANNIER & GANNIER, 1990; FABRI & LAURIANO, 1990), Thyrrenian sea (CONSIGLIO *et al.*, 1990), Corsica, Sardinia and Sicily (NOTARBARTOLO *et al.*, 1990), Adriatic sea (SERMAN & SERMAN, 1990), in the Ionic sea (POLITI *et al.*, 1990) and in the northern western Mediterranean (AGUILAR, 1990; AGUILAR *et al.*, 1992; FORCADA *et al.*, 1990) and only a few studies have taken place in the Alborán sea (FORCADA *et al.*, 1990; AGUILAR *et al.*, 1992). From 8 to 27 July 1993, a cetacean survey cruise took place between 6°12'00"W and 2°0'00"W in the Alborán Sea and Gibraltar Strait waters. The observation platform was placed at 5 m. above sea level. A total of 127 hours of observations were made on board of the R/V Francisco de Paula Navarro during the IEO ICTIO ALBORAN 0793 cruise, covering a distance of 1288 n. miles (Fig. 1) with an area of 13.213 n m^2. Line transect sampling methods (BURNHAM *et al.*, 1984) were used to analyze the data and to calculate the estimation of abundance for the whole area. Along with the date and time sightings, position, species, number of individuals, depth, distance to the coast, and distance to the sighting data of sea conditions, temperature, atmospheric conditions and visibility were also recorded together data of the cetacean behavior, school type, speed and course, swimming behavior, attraction to the vessel, the birds and to the other fauna. The total number of sightings was 62. The species encountered were *Delphinus delphis* (31%), *Globicephala melas* (26%), *Stenella coeruleoalba* (23%), *Tursiops truncatus* (18%), *Physeter macrocephalus* (1%) and *Grampus griseus* (1%). The LDS (density of sightings) was calculated giving a value of 0.048 schools/n.mile. Estimates for grouping index, distance to the coast, behavior, temperature ranges, etc., for the different species are given in table I.

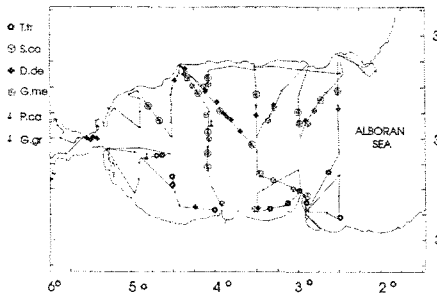


Fig. 1. Area surveyed and situation of the sightings.

REFERENCES

AGUILAR A., 1990. Calvin in the striped dolphin from the western Mediterranean sea. pp. 67-68. *In* European Research on Cetaceans. - 4. Proc. 4 Th. Ann. E. C. S. Conf.

AGUILAR R., PASTOR X. & FORCADA J., 1992. Results of the Greenpeace Cetacean Survey Cruises during the western Mediterranean striped dolphin epizootic.

BURNHAM K.F., ANDERSON D. R. & LAAKE J. L., 1984. Estimation of density from line transect sampling of biological populations. Wildlife monogr. 72 : 1-202.

CONSIGLIO C., MARINI L., ANGRADI A. & SANNA A., 1990. A medium-trem sighting schems on cetacean in the central Thyrrenian sea. pp. 44-45. *In* European Research on Cetaceans. *op. cit.*

FABRI F. & LAURIANO G., 1990. Greenpeace report on two year research in the Ligurian sea. pp. 69-71. *In* European Research on Cetaceans. *op. cit.*.

FORCADA J., AGUILAR A., HAMMONF P., PASTOR X. & AGUILAR, R., 1992. Striped dolphin abundance in the Western Mediterranean Basin after 1990 epizootic. The Mediterranean Striped Dolphin Die-off. Proc. of the Mediterranean striped dolphin mortality International Workshop. Palma de Mallorca.

GANNIER A. & GANNIER G., 1990. Cetacean sighting in the Mediterranean sea. Second Report. pp. 39. *In* European Research on Cetaceans. *op. cit.*

MARINI L., CONSIGLIO C., ANGRADI A., SANNA A & VALENTINI T., 1990. Cetacean sightings programme in the central Thyrrenian sea. pp. 66-67. *In* European Research on Cetaceans. *op. cit.*

NOTARBARTOLO G., VENTURINO M.C., ZANARDELLI M., BEARZI G., BORSANI F., CAVALLONI B., CUSSINO E., JAMODA M. & ATROLDI S., 1990. Distribution and relative abundance of cetaceans in the central Mediterranean sea. pp. 41-43. *In* European Research on Cetaceans. *op. cit.*

POLITI E., BEARZI M., NOTARBARTOLO DE SCIARA G., CUSSINO E. & GNONE G., 1990. Distribution and frecuency of cetaceans in the waters adjecent the greek ionian islands. pp. 75-78. *In* European Research on Cetaceans. *op. cit.*

SERMAN D. & SERMAN A., 1990. Marine mammal conservation status and research in the eastern Adriatic sea. pp. 54-55. *In* European Research on Cetaceans. *op. cit.*

Table I. Summary of all data obtained in the sightings.

	D. del.	*G. mel.*	*S. coe.*	*T. tru.*	*P. mac.*	*G. gri*
n° sigthings	19	16	14	11	1	1
n° individuals	236	118	129	57	1	1
LDS	0,014	0,012	0,01	0,008	0,0008	0,0008
Compact groups	1	6	1	1	-	-
Sparse groups	18	10	13	10	-	-
Isolated individuals	0	0	0	0	1	1
Average n°individ./group	12,42	7,37	9,21	5,18	1	1
Attraction to the vessel	12	6	3	6	-	-
Move away from the vessel	0	1	0	0	-	-
Indifferent to the vessel	7	9	11	5	1	1
Stationnary swimming	2	7	5	1	-	-
Slow swimming	13	12	13	8	1	1
Fast swimming	6	0	0	3	-	-
Showing the back	18	16	13	10	1	1
Showing the caudal fin	4	0	6	2	-	-
Jumping	15	0	7	1	-	-
Maximum depth	1300	1500	1400	1150	700	1300
Minimum depth	80	375	75	30	700	1300
Average depth	685	869	727	407	700	1300
Max. distance to the coast	2,2	10,1	3,8	1,0	23,8	34
Min. distance to the coast	39,8	39,6	42,0	32,0	23,8	34
Ave. distance to the coast	15,9	24,7	18,8	13,7	23,8	34
Max. water temperature	21,3	23,9	23,6	23,2	20,8	21,8
Min. water temperature	18,6	21,4	21,3	20,8	20,8	21,8
Ave. water temperature	20,2	22,4	22,4	21,8	20,8	21,8

DAILY EGG PRODUCTION SPAWNING BIOMASS OF THE NORTH-WESTERN MEDITERRANEAN ANCHOVY DURING 1993 (CATALAN SEA, GULF OF LIONS AND LIGURIAN-N TYRRHENIAN SEAS)

A. GARCÍA[1], I. PALOMERA[2], J.P. RUBÍN[1], N. PÉREZ[1], O. GIOVANARDI[3] and P. RUBIÉS[2]

[1] IEO. Centro Oceanográfico de Málaga, P.O. Box 285. Fuengirola, Málaga, Spain
[2] Instituto de Ciencias del Mar (ICM),Paseo Joan de Borbó s/n, 08039 Barcelona, Spain
[3] Ist. Centrale Per La Ricerca Scientifica e Tecnologica applicata al Mare, Roma, Italy

Research carried out by HUNTER AND GOLDBERG (1980) on the reproductive aspects of the northern anchovy off California Engraulis mordax, showed that many small pelagic species, mainly clupeiforms were batch spawners. Subsequently, an ichthyoplankton based method (LASKER, 1985), the Daily Egg Production Method, was developed that allowed the spawning biomass estimate of Clupeoids. The first applications of DEPM in European waters were carried out in the coasts of the Atlantic Iberian peninsula on the Iberian sardine, *Sardina pilchardus* (GARCÍA *et al.*, 1992) during 1988, and on the Bay of Biscay anchovy, *Engraulis encrasicolus* (SANTIAGO and SANZ, 1992). The first Mediterranean DEPM survey was carried out by PALOMERA and PERTIERRA (1993) on the anchovy from the Catalonian coasts. Within the framework of a an EU financed FAR project, the northwestern Mediterranean anchovy biomass was estimated through DEPM (MPH-MED-93) aboard the R/V García del Cid during July, 1993. This survey was combined spatially and temporally with the echo-acoustic survey, PELMED-93 on board the R/V Thalassa, with the purpose providing the anchovy echo-integration biomass estimates and allowing to estimate DEPM parameters related to the adult stock. The DEPM sampling and data treatment methodology in relation to the egg and adults survey are described in GARCÍA (1994). In summary, the basic scheme of egg sampling stations was based on a 5 by 5 nautical mile track, with transects perpendicular to the coastline. A total of 602 CalVET net (150 µ mesh) vertical tows of 100 m depth were done, representing a coverage of 59,981 km^2 of sea surface. Catalán Sea accounted for 292 plankton hauls, whereas the Gulf of Lions and Ligurian Sea accounted for 138 and 172, respectively.

Adult anchovies were sampled in 34 positive anchovy hauls (13 in Catalonian waters, 13 in the Gulf of Lions and 8 in the Ligurian-N Tyrrhenian) with an epipelagic trawl. The period of trawls ranged from 7:30 A.M. to 22:30 P.M. (GMT). 1,034 ovaries were collected, where 210 corresponded to hydrated females. The model (LASKER, 1985) is based on the following equation, where B = spawning biomass in metric tons, Po= daily egg production (number of eggs per sampling unit, 0.05 m^2), W = average weight of mature females (grams), R = sex ratio (fraction mature of females by weight), F = batch fecundity (mean number of eggs per mature female per spawning), A = total survey area (in 0.05 m^2 sampling units). S = fraction of mature females spawning per day. Plankton stations are post-stratified by location (negative and positive strata) with the purpose of decreasing variance and by geographic criteria based on the spawning area distribution (GARCÍA, 1994). Eggs were staged according to their embryonic degree of development and subsequently aged, taking into account an specific temperature-dependent egg development model, through the program STAGEAGE. Egg production, Po, is estimated by fitting the exponential mortality function using a weighted nonlinear least squares regression to the data egg file. This model was fit to the data from stratum 1 for each of the regions. In consequence, each region has an estimate of Po1 (intercept) and a corresponding egg mortality, z (slope). The final stratified estimate of Po by regions was calculated as the weighted average of the two strata. In reference to the adult parameters estimates, W, F, S and R, mean and variance were estimated following PICQUELLE and STAUFFER's (1985) weighing procedure, calculating weighted averages albeit the number of sampled individuals are not equal in each of the tows. W, the mean weight of mature females per trawl was adjusted for those females which were in the hydrated condition, through the following regression, W = -0.3261 + 1.1012W* (ovary-free weight of non-hydrated females). F, batch fecundity, is estimated by regressing batch fecundity on ovary-free weight of hydrated females, without post-ovulatory follicles. A total of 83 hydrated females were obtained. The resulting linear regression is : y = 1848,3 + 499,57 x R = (0.92). Weights of the females used ranged from 3.6 to 30.6 g, while sizes ranged from 9.1 to 17.5 cm. S, fraction of mature females spawning per day, is determinated by the histological analysis of post-ovulatory follicles. These were assigned ages according to the following: Day-0 PO = 0-7 hours; Day-1 PO = 8-31 hours; Day-2 PO = > 31 hours. Day-1 PO has been used in the estimate of S, since Day-0 PO are oversampled during the daily spawning period in anchovy (ALHEIT, 1985). R, sex ratio, is calculated as the fraction in weight of mature females. Based on the geographical distribution of the anchovy population and the spawning grounds distribution, the defined stratified regions were : Catalán Sea and Gulf of Lions, which have common geographical, hydrographical and environmental characteristics, as opposed to the Ligurian-N Tyrrhenian Sea, which presents a distributional barrier along the Provençal coasts, probably due to the narrow shelf limits. The results of all the DEPM parameters estimate and the final anchovy spawning biomass estimate are in following table. When comparing by regions the different parameters estimate, no great differences are observed between the adult parameters. However, in comparison to the Bay of Biscay anchovy, it should be remarked that the average female weight is much lower and consequently, batch fecundity (aproximately 30 g and 15 000 eggs/batch, respectively). Nevertheless, spawning fraction is within the same range (0.30). Daily egg production over the surveyed regions are in the same order of magnitude, but with high mortality (z), specially in the Ligurian-N Tyrrhenian Sea, in comparison to Bay of Biscay anchovy estimates (SANTIAGO and SANZ, 1992). Higher Mediterranean temperatures account for the faster egg development rates that eventually result in shorter egg durations. The temporal and spatial simultaneous coverage of both surveys have contributed to the similarities in the biomass estimates, except the case of the Italian waters in which daily egg production probably is over-estimated.

DEPM Parameters	Catalán Sea - Gulf of Lions	Ligurian-N Tyrrhenian Sea
Po1	5.215	4.990
c.v.	0.145	0.223
z	1.063	1.551
c.v.	0.136	0.280
Po	2.382	2.715
c.v.	0.258	0.229
Adn 0.05 m^2)	6.911×10^{11}	3.085×10^{11}
A(in km^2)	44.567	15.420
W (g.)	14.31	14.17
c.v.	0.074	0.068
F	4958	4904
c.v.	0.11	0.10
S	0.31	0.30
c.v.	0.13	0.11
R	0.65	0.60
c.v.	0.05	0.05
Biomass (MT)	30.565	12.129
c.v.	0.33	0.30
Acoustic Biomass (MT)	32.831	6.459

REFERENCES

ALHEIT, J., 1985. *Technical Rep.* NMFS 36:59-62.

GARCÍA, A. (Ed.), 1994. Final Report Study Contract FAR Proyect MA 3.730. U.E. DG XIV

GARCÍA, A., N. PÉREZ, N.C.H. LO, A. LAGO DE LANZÓS and A. SOLA, 1992. *Bol. Inst. Esp. Oceanogr.*, V. 8, N° 1: 123-138.

HUNTER, J.R. and S.R. GOLDBERG, 1980. *Fish. Bull.* U.S. 77: 641-652.

LASKER, R. (Editor), 1985.*NOAA Technical Rep.* NMFS 36: 99 p.

PALOMERA, I. and PERTIERRA, J.P., 1993. *Sci. Mar.*, 57(2-3): 243-251.

PICQUELLE, S.J. and G. STAUFFER, 1985. *NOAA Technical Rep.* NMFS 36:7-16.

SANTIAGO, J. and A. SANZ, 1992.*Bol. Inst. Esp. Oceanogr.*, V. 8, N° 1: 225-230.

INTRODUCTION À L'ÉTUDE DE LA PRISE DE NOURRITURE CHEZ *URANOSCOPUS SCABER* L. (PISCES, PERCIFORMES)

Véronique GOOSSE, Laurence HUET et Pierre VANDEWALLE
Université de Liège, Institut de Zoologie, 22, quai Van Beneden, 4020 Liège, Belgique

Uranoscopus scaber LINNE 1758 est un poisson méditerranéen qui se nourrit en chassant à l'affût. Enfoui dans le sable presque jusqu'aux yeux, il attend sa proie. Au moment propice, il la saisit ou tente de la saisir par un bond rapide hors du substrat. Le but de l'étude est de rechercher en quoi les mouvements de prise de nourriture sont originaux chez *Uranoscopus scaber*. Nous en présentons ici une des composantes : l'élévation de la tête.

Le poisson est placé dans un aquarium étroit (sans sable) sous lequel se trouve un miroir incliné à 45°, permettant ainsi une observation simultanée en vue latérale et ventrale. La prise de nourriture a été filmée à 400 images par seconde et les scènes de film ont été analysées au moyen d'une table permettant une digitalisation immédiate des coordonnées de points choisis sur le poisson. La nourriture fournie est constituée uniquement de poissons comparables à ceux trouvés dans les estomacs.

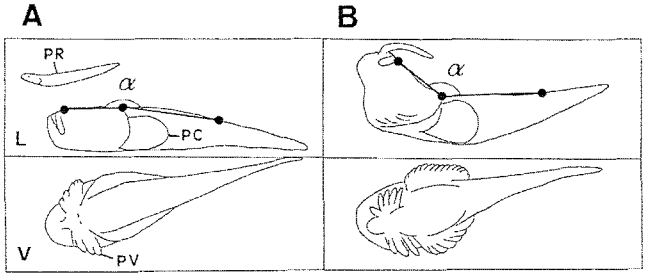


Figure 1: Vues latérales (L) et ventrales (V) du poisson et de la proie. A: situation précédant la prise de nourriture; B: situation au moment de la flexion maximale de la tête et du corps.
α : angle formé par la tête et le tronc; PC : nageoire pectorale; PR : proie; PV : nageoire pelvienne.

Lorsqu'une proie passe au-dessus de *U. scaber*, celui-ci projette très rapidement la bouche vers le haut. Il en résulte une pliure importante qui apparaît en arrière de la tête (fig. 1). Cette pliure entraîne une variation de l'angle que forme la tête et le tronc de 60° et plus (fig. 2B). Avant la pliure, il y a une incurvation du poisson en sens opposé (fig. 2A). Après un mouvement d'arrêt en position pliée, le retour à l'état de départ est d'abord rapide, puis lent (fig. 2A). Au maximum de la pliure, le poisson ne touche plus le fond de l'aquarium (fig. 1B).

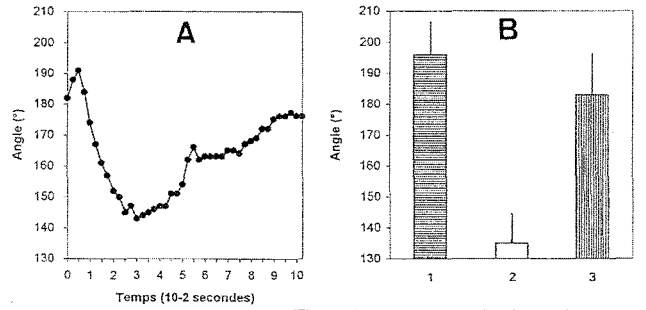


Figure 2 : A. Variations de l'angle α (Figure 1) au cours d'une prise de nourriture.
B. Moyennes de l'angle α avant (1) la prise de nourriture, au moment de la flexion maximale (2) entre la tête et le tronc et après (3) la prise de nourriture.

Discussion.

1. Les Actinopptérygiens disposent de différents systèmes pour abaisser la mandibule et ouvrir la bouche. L'élévation du neurocrâne peut être l'un d'eux (VANDEWALLE, 1978; LIEM, 1979). Une élévation du neurocrâne pendant la prise de nourriture a été décrite chez certains poissons (LAUDER, 1979; LAUDER et LIEM, 1981; SIBBING, 1982, ...) mais jamais elle n'atteint l'ampleur de celle observée chez *U. scaber*.

2. MULLER et OSSE (1984) pensent que *U. scaber* projette la tête vers le haut en prenant appui sur les nageoires pectorales et pelviennes. S'il en était ainsi, tout le corps serait soulevé de la même manière. Nous pensons que c'est principalement la contraction de la musculature épaxiale juste en arrière de la tête qui provoque une pliure en soulevant la tête et le corps en sens opposé. Cette action est en plus favorisée par une extension préalable de la musculature épaxiale comme le montre la figure 2A.

REMERCIEMENTS. Cette étude est subsidiée par le F.N.R.S. (programme 2.9006.90). Nous remercions le Dr. D. BAY de la Station océanographique STARESO (Calvi, Corse) qui nous a procuré les spécimens nécessaires à cette étude. P.V. est chercheur qualifié au F.N.R.S.

REFERENCES

LAUDER G.V., 1979.- *J. Zool. Lond.*, 187, 543-578.
LAUDER G.V. et LIEM K.F., 1981. - *Env. Biol. Fish.*, 6, 257-268.
LIEM K.F., 1979.- *J. Zool. Lond.*, 189, 93-125.
MULLER M. et OSSE J.W.M., 1984.- *Trans. Zool. Soc. Lond.*, 37, 51-135.
SIBBING F.A., 1982.- *J. Morphol.*, 172, 223-258.
VANDEWALLE P., 1978.- *Cybium*, 3, 15-33.

MULLUS SURMULETUS (L. 1758) : DECAPODA SELECTIVE PREDATION

GUILLÉN J.E. & MARTÍNEZ HERNANDEZ M.
Institut d'Ecologia Litoral. C/ Benimagrell 5. El Campello. Alicante, Spain

In the Southeastern of Spain, the Red Mullet (*Mullus surmuletus*) is a basic species for artisan fisheries. The fisheries are made with trammel nets. The fishing period ranges from the end of May to December. The study was made sampling with the commercial fisheries methods. The maximum of catches (expressed in kg per net piece -50 a 55 m) was obtained in July, and was equal to 0,6 kg/net. Another maximum value was obtained after the summer season, viz., in October (0,9 kg/net), time in which young specimens are by far the most predominant in captures (MARTINEZ HERNANDEZ, 1993).

The zone of red mullet fisheries in the research area is limited to the deep limit of the *Posidonia oceanica* meadow, namely from 21 to 23 meter depth. It forms an ecotone between the meadow and the muddy sand biocoenosis, and has been degraded due to illegal trawling. After the installation of an extensive antitrawling artificial reef in 1992, trawls were eliminated (RAMOS *et al.*, 1993). Nets are placed by fishermen at night time (4 GMT in Summer, and 6 GMT in Autumn), and they are retrieved at about one hour after dawn. Since then, Red Mullets captures are very low.

79 specimens of Red Mullet were analysed, their size class (HOLDEN & RAITT, 1975) were : 13-14.9 (3 specimens), 15-16.9 (28), 19-20.9 (15), 21-22.9 (6), 23-25 mm (4), and no significative differences were observed between size classes and stomach contents.

The result of the study of Red Mullet's stomach is shown in figure 1a. Crustacea constitute the main part of the total preys of *M. surmuletus* (81,45%), the remaining part is composed mainly by polichaeta, nematoda, sipunculida, and mollusca, in wich the presence of *Seppiola* sp. must be pointed out. Decapoda stand for the great majority of Crustacea (fig. 1b). In this group, *Processa* sp., and *Sycionia carinata* (22,03 %, and 18,64 % of the total of Decapoda, respectly), can be considered as the main species.

In the study area, *Processa modica* var. *carolii* is the most abundant species of the genus. Although we also have also sampled one specimen of *P. macrophtalma.*, *P. modica carolii* is a very common species in the meadow and makes massive movements to other near biocoenosis, like fine sandy bottoms (GUILLEN & PEREZ-RUZAFA, 1993).

S. carinata is not a common species in the study area. As it has burial habits, its sampling is quite complex. The high percentage of this species in the preys of *M. surmuletus* can suggests that there is a selective predation for this decapod.

Apart from that, we have researched activity patterns along the day for this Decapoda species. The results obtained show the existence of a night activity for both species, with a midnight highest activity; after this period, the percentage of captures decrease, and practically disappear at midday. At that time, *S. carinata* is buried in sandy bottoms and *P. modica carolii* is hidden in the rizoma and leafs of the meadow. The change of light at daybreak makes the Red Mullet be at its greatest activity, looking for preys. Due to this fact, it is more easily captured with nets. Then, we can suggest the selective predation for these decapoda species as one of the most important facts for artisan fishing.

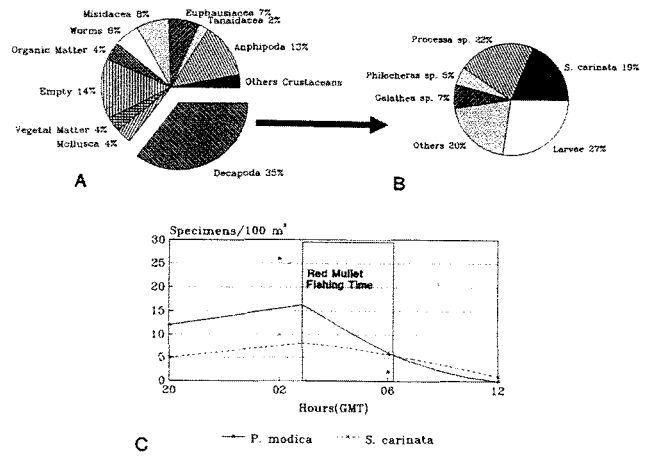


Figure 1. A: Preys composition in M.surmuletus.
B: Decapod's composition. C: Day activity for *P. modica carolii* and *S. carinata*.

REFERENCES

GUILLEN, J.E. & PEREZ-RUZAFA, 1993. Composición, estructura y dinámica de poblamientos de crustáceos decápodos asociados a las comunidades arenosas del SE ibérico. *Publ. Espec. Inst. Esp. Oceanogr.* 11 : 175-183.
HOLDEN, M.J. & RAITT, D.F.S. 1975. Manual de ciencia pesquera. Parte 2 - Métodos para investigar los recursos y su aplicación. Doc. Téc. FAO. Pesca (115) Rev. 1. 211 pp.
MARTINEZ HERNANDEZ, M. 1993. Datos preliminares sobre la pesquería artesanal de El Campello (Alicante) en relación a las especies demersales. *Publ. Espec. Inst. Esp. Oceanogr.* 11 : 375-381.
RAMOS ESPLA, A.A., MARTINEZ PEREZ, L., ARANDA, A., GUILLEN, J.E., SANCHEZ JEREZ, P. & S NCHEZ LIZASO, J.L. 1993. protección de la pradera de *Posidonia oceanica* (L.) Delile mediante arrecifes artificiales disuasorios frente a la pesca de arrastre ilegal; el caso de El Campello (SE ibérico). *Publ. Espec. Inst. Esp. Oceanogr.* 11 : 431-183.

V

SARDINA PILCHARDUS (WALB.) FRY FISHERY IN A MIDDLE TYRRHENIAN BAY (SALERNO, ITALY): BIOLOGICAL, TECHNOLOGICAL AND MANAGEMENT ASPECTS

IANNIBELLI, M. and LEVI, D.

Istituto di Tecnologia della Pesca e del Pescato, C.N.R. Mazara del Vallo, Italia

Sardina pilchardus (Walb.) fry fishery for consumption purpose is an activity with a very old tradition in Italy, about which information can be found since 1314. At present fishing is allowed from Dec. 1 to Apr. 30 but only for two months per year, under the provisions of the Local Fishery Consultant Commission. One of the italian areas in which this fishing activity is mostly practiced is the Gulf of Salerno, and so we chose it for this research. The ichthyofaunal spectrum analysis results of this fishery have been already published in a preceeding work (IANNIBELLI and LEVI, 1992). In order to obtain information on the motor-boats and the fishing gears used, the mostly frequented areas, the techniques used, etc. we have distributed questionnaires to all the fishing crews in the site investigated, who fill in this information daily. Similarly, in order to get information on the quantities caught, we obtained the data directly from the motor-boats, considering that a great part of the catch is not sold on the fish-market, but is given directly to peddlers or to sellers with standard stores. The motor-boats used are between 5 and 8 mt length overall and their tonnage 1.5 - 5 gross tons. The boat motors are 12 - 60 H.P. and are always exclusively Diesel. At present the boats used in Salerno Bay are 30, less than a half of the ones used in the years around 1960 and equal in number to those used in the years around 1930. The fishing gear used is a so-called net "rezzola", typical in the area, which is a hand-trawl net, working on the sea surface and which is drawn directly from the boat, while until the years around 1880 fishermen used to pull the net from the seashore. The innovation of drawing hand-trawl nets from the boats, which has been diffused by the presence of this kind of gear also in southern Italy since the middle of the last century, has allowed to operate with a less numerous crew and also to capture shoals of fishes otherwise uncatchable. Another gear used is the hand scoop net (50 cm in diameter), always nightly and with a light source, as reported also by CREAC' H (1952) for a similar fishing activity carried out in the Antibes area.

The fishing action operates at a distance of 300 mt approximately from the shore, never more than 1 km, and this also is in full accord with the literature (DE BUEN, 1930, 1931). Fishing is carried out in areas 3-45 mt deep, on generally sandy sea-bottoms. The depth and the nature of the sea-bottoms on which sardine fry is caught in greater quantity are, here too, according to literature (HOLDT, 1899; LO BIANCO, 1911; PAOLUCCI, 1912; LA GALL, 1928; FURNESTIN, 1959; LEE *et al.*, 1967). It has been observed that when the fishing-action is carried out between 2.5 and 5 mt depth fishermen try to circumscribe with the net depressions more or less accentuated of the sea-bottom called "fosse" in which the greatest quantity of the fry collect after their appearance in the area. Actually, the sardine fry in Salerno Bay arrive near the coast favoured by the current of the South, the East and the West and they trend to assemble in this little natural shallow pit on the sea-bottom, where they can better resist the current, and which they will abandon, if not caught first, to reach the currents of the North, that bring them again to the open sea. These direct observations are in full accordance with LARRANETA and LOPEZ (1957) and DE BUEN (1931), whereas ROULE (1932) also describes the opposite action section used by MISTRAL and SCIROCCO in relation to the "poutine" fishery on the Nice coast. Being that the period of deposition of he eggs and the growth average of sardine larvae and post-larvae is very variable from one year to another, depending on temperature, salinity and many other factors as reported in numerous works of the sardines (LARRANETA and LOPEZ, 1957; LEE, 1961; KARLOVAC, 1967; LEE *et al.*, 1967; FURNESTIN and FURNESTIN, 1959; GAMULIN and HURE, 1955) it is clear that the fishing period varies in relation to all that has been above mentioned.

The technique of sardine fry fishery for commercial purposes in Salerno bay, is simple enough, and corresponds with some variations, to that used for fishing from the boat with a hard-trawl net. The daily number of holds goes from a mininum of 1 to a maximum of 55, with a media of 17 holds for day. The average time for outgoing and incoming fishing is 5:30 and 1:00 A.M., while for night fishing it is 9:00 P.M. and 6:00 A.M. The time to reach the fishing areas is 65 min. approximately. The number of the crew components varies from a mininum of 2 to a maximum of 5 persons. The sardine fry in the Gulf of Salerno, was always considered a highly valued fish product. Its easy perishability creates a serious guaranty for the consumers, since it is extremely difficult to keep it in good condition for a long period. Moreover the value fish fry increases when it is composed of similar size fishes, 25-28 mm at maximum, as it can easily be observed. It has been proved, further, that if proteins increases in adult sardines respect to fish fry, sardine fry fat contents is 3% whereas that of adults is 8% (VINCENT CUAZ and POURTALLIER, 1973). The first is considered a lean fish and is justly esteemed of greater value than the second that is considered fatty.

Regarding the market of sardines fish fry in Salerno, from the analysis of gross proceeds for every gram, during the fishery days, comes out a rapidly increasing trend. This seems to indicate some form of saturation of the market request, and searching a correlation between the value in grams of fish fry and the total quantity of the catch, it was found a significant negative correlation (-044601) demonstrating that the value in grams of fish fry and the total quantity of the catch diminishes with the growth of it. From a management point of view, therefore, it would be unproductive an extension of the fishing season, or a raise in the boat fishing number. More productive, instead could be revealed the study of a method to refrigerate the fish on the boats, as well as its eventual transformation in a canned product, under oil, or in another type of conservation. The possibility of utilizing in the best way the period of two months allowed, succeeding to individualize quickly the fishing-target, would be another strategy that could bring to the best yield of the investigated activity.

REFERENCES

CREAC'H P., 1952. Rev. Trav. Off. Pêches Marit., 17 : 57-60

DE BUEN F., 1930. Clupéidés et leur pêche. Rapp. Proc. verb. C.I.E.S.M. 5 : 173-194.

DE BUEN F., 1931. Clupéidés et leur pêche. Rapp. Proc. verb. C.I.E.S.M. 6 : 389-436.

FURNESTIN J. and FURNESTIN M.L., 1959. *Rev. Trav. Inst. Pêches Marit.*, 23 : 79-104.

GAMULIN T. and HURE J., 1955. *Acta Adriatica*. 7 : 1-23.

IANNIBELLI M., and LEVI D., 1992. Commercial fishery of *Sardina pilchardus* Walb. fry in the Gulf of Salerno (Southern Italy): ichthyofaunal composition: Rapp. Proc. verb. C.I.E.S.M. 33: 295.

KARLOVAC J., 1973. Oscillations des quantités des stades planctoniques de la sardine, *S. pilchardus* Walb..... 1965/66 jusqu'a 1969/70. *Rapp. Comm. int. Mer Médit.*, 21: 813-815

LARRANETA M.G. and LOPEZ J., 1957. *Inv. Pesq.*, 6:53-82.

LEE J.Y., 1961. La sardine du Golfe du Lion. *Rev Trav. Inst. Pêches Marit.*, 25: 417-511.

LEE J.Y., PARK J.S., TOURNIER H. and ALDEBERT Y., 1957. Ibidem, 31 : 343-350.

LE GALL J., 1928. Notes et observations sur la biologie de la sardine de la Manche. *J. du Conseil.* 3: 206-223.

LO BIANCO S., 1911. *Mitt Zool. Stat. Neapel*, 20 :129-156.

PAOLUCCI C., 1913. *Riv. Mensile di Pesca*, 15 : 33-60.

ROULE L., 1933. Les Poissons Tome V : Larves et metamorphoses Delagrave, Paris. 309 pp.

VINCENT - CUAZ L. and POURTALLIER J. 1973. La poutine pêchée sur le littoral du département des Alpes Maritimes en 1970. *Rapp. Comm. int. Mer Médit.*, 21 : 773-776.

RÉGIME ALIMENTAIRE DE L'ESPADON *XIPHIAS GLADIUS* (L.1758) DU GOLFE D'ANNABA

Farouk IFRENE

Private Maritim's Research Corporation, Lotissement Petite Provence N°3, Paradou Hydra 16035, Algérie

Un échantillonnage de 29 appareils digestifs (viscères) a été prélevé sur des espadons pêchés au chalut pélagique dans le golfe d'Annaba dans la Région orientale de la côte algérienne durant les mois de décembre 1990 et de janvier 1991 et analysés juste après au Laboratoire de Biologie Marine de l'Université d'Annaba.

La pratique d'une dissection longitudinale de la cavité stomacale est suivie d'une analyse macroscopique du contenu. Les proies sont ensuite classées par espèce et par degré de dégradation digestive. Une substance gluante dans l'estomac est observée afin de détecter les proies microscopiques si elles existent. Les données enregistrées lors de l'identification des proies, nous ont permis d'utiliser la méthode qualitative pour la liste des différentes proies collectées, complétée par la méthode quantitative numérique pour l'importance relative des proies dans la composition de la nourriture globale, utilisant les indices suivants (HYNES, 1950 *in* QUINIOU, 1978) : 1) - Fréquence de proies (F). 2) - Pourcentage en nombre (Cn)
3) - Coefficient de vacuité (Cv).4) - Nombre moyen de proies (Nm).

Résultats et discussion :

- Le coefficient de vacuité est nul (Cv = 0). Aucun espadon n'avait l'estomac vide. Le contenu individuel varie entre 1 et 51 proies.
- Les espadons traités vivaient dans une zone de proies très variées et très abondantes (environ 20 espèces pêchées pour 150 à 500 casiers de poissons pélagiques, par sortie).
- Le nombre moyen de proies ingérées est de 17, avec une moyenne de 34 en décembre et de 11 en janvier. Les proies ont été identifiées aux espèces suivantes : *Sardina pilchardus* (Sardine), *Sardinella aurita* (Allache), *Engraulis encrasicolus* (Anchois), *Trachurus trachurus* (Saurel), *Loligo vulgaris* (Calmar), *Boops boops* (bogue), *Trigla lyra* (Grondin), *Cepola macrophtalmus* (Cepola). En plus des proies recensées deux vers se trouvant dans 27 estomacs ont été identifiés; l'un plat et segmenté : un Cestodes des familles des Diphyllobothriidae (ARTÜZ, 1963) et l'autre de section ronde : un Nématodes du genre *Contracaecum incuruum* (DIEUZEÏDE, 1933).
- Sur les 478 proies recensées, seulement 1,04% est benthodémersale, le reste (98,96%) était d'origine pélagique.
- Les proies pélagiques se trouvaient dans tous les estomacs (F=100%), donc considérées par l'espadon comme aliment préférentiel, contrairement aux proies benthodémersales (F=17), secondaires ou plutôt accidentelles.
- Le nombre de proies comptabilisées en décembre est supérieur à celui de janvier. L'allache est quasi-absente en janvier dans les estomacs d'espadon.
- Sur les 478 proies, 49,58 % sont des sardines, 13,18 % des allaches, 12,55 % des anchois, 2,30 % des calmars et 0,42 % des saurels.
- Dans les proies pélagiques, la sardine est classée comme préférentielle alors que l'allache, l'anchois et le calmar sont secondaires dans le régime alimentaire de l'espadon et le saurel trachurus est accidentel.
- 98 % des proies étaient disposées et orientées la tête au fond de l'estomac.

Tableau récapitulatif des variations mensuelles des fréquences de proies et des pourcentages en nombres.

Groupes	PROIES Familles	Espèces	DECEMBRE F (%)		Cn		JANVIER F (%)		Cn	
Pélagiques	Clupeidae	S. pilchardus	100.00		46.79		100.00		53.05	
		S. aurita	75.00		23.77		00.00		00.00	
	Engraulidae	E. encrasicolus	37.50	100	09.43	98.85	38.09	100	16.43	99.06
	Carangidae	T. trachurus	00.00		00.00		09.52		00.94	
	Loligidae	L. vulgaris	25.00		01.13		28.57		03.76	
	Petit poisson	pélagique indéterminé	62.25		17.70		66.67		24.88	
Bentho-démersaux	Sparidae	B. boops	12.50		01.13		00.00		00.00	
	Triglidae	T. lyra	00.00	12.5	00.00	01.13	04.76	19.05	00.47	00.94
	Cepolidae	C. macrophtalmus	00.00		00.00		04.76		00.47	

	Décembre	Janvier
Nombre d'estomacs examinés :	08	21
Nombre total de proies :	265	213
Nombre moyen de proies par estomacs :	33.12	10.14

La neutralité du coefficient de vacuité confirme la réputation de voracité de l'espadon et laisse ainsi supposer d'autres possibilités, notamment :
- Relativement au nombre moyen des proies par estomac, l'espadon n'aurait pas de problème de disette alimentaire. Les proies étant dans ce cas généralement comparables, le problème de taille et de valeur nutritive devient secondaire.
- Le changement remarquable de l'allache, présente en grand nombre dans le régime alimentaire de l'espadon en décembre, qui disparaît totalement en janvier, s'expliquerait par une abondance relative intrinsèque.

L'espadon présente un régime alimentaire carnivore de constituants macro-pélagique; sachant que la morphologie de sa bouche précédée par un long rostre l'empêche de chasser sur le substrat, les proies benthodémersales ont certainement été ingérées durant leurs phases pélagiques. Relativement à l'importante quantité de poissons variés pêchés au chalut pélagique en même temps que l'espadon échantillonné, ce dernier se nourrit essentiellement de clupéiformes, du fait que les petits espadons -qui ont surtout fait l'objet de cette étude- ont une bouche peu développée et dépourvue de dents, qu'ils préfèrent manger les clupeiformes à corps tendre, facilement ingérables et digérables, mais aussi du fait du comportement de cette proie qui vit en bancs assez concentrés augmentant ainsi la chance de prise en un minimum d'efforts.Vu que les proies, une fois prises dans la bouche de l'espadon ne subissent aucune transformation (broyage, dégradation) à travers le tractus jusqu'à l'estomac, on suppose en raison de leur disposition (tête orienté vers le fond de la bouche et de l'estomac) que le prédateur dispose d'une technique de chasse particulière : il aborderait les bancs de poissons pélagiques de face.

RÉFÉRENCES

ARTÜZ, N. I., 1963 : Contribution à l'étude de la biologie de l'espadon *XIphias gladius* de la mer Marmara. *Proc. Gen. Fish. Coun. Med.* 7 : 183 - 47.

DIEUZEÏDE, 1933 : Station d'aquaculture et de la pêche de Castaglione.

MAURIN ET CLAUDE, 1970 : *Revue des travaux de l'Institut des Pêches Maritimes*. XXXIV (2) : 256.

QUINIOU, L. (1978) : Les poissons demersaux de la baie de Douarnenez, alimentation et écologie. Thèse de Doctorat 3ème cycle, Université de Bretagne Occidentale : 222p.

V

ACOUSTIC SURVEYS IN THE SPANISH MEDITERRANEAN SHELF (1982-1993)

M. IGLESIAS, J. MIQUEL, P. OLIVER & F. ALVAREZ
Centro Oceanográfico de Baleares, IEO, Spain

Since 1982, the Spanish Institute of Oceanography (IEO) has been doing systematic hydro-acoustical surveys to evaluate coastal pelagics in the Spanish Mediterranean shelf (20-200 m depth), covering the area between Punta Europa and Cabo de Creus. Five zones have been considered : Alborán, Vera, Alicante, Valencia and Cataluña.

Although sardine (*Sardina pilchardus*) and anchovy (*Engraulis encrasicholus*) are the target species, other important species are round sardinella (*Sardinella aurita*), horse mackerel (*Trachurus trachurus; T. mediterraneus* and *T. picturatus*) and mackerel (*Scomber scombrus* and *S. japonicus*).

These species are mixed and the echograms and catches are normally multispecific, being sometimes very difficult to allocate the echointegration.

Acoustic surveys have been carried out on R/V "Cornide de Saavedra", a 67 m long, 2500 HP stern trawler. Prior to each survey, the SIMRAD echosounder system was calibrated using a 60 mm copper standard target sphere with a TS= -33.6 dB. Biological data were collected using a pelagic trawl gear with a 20 mm codend and provided with a Simrad FR-500 netsonder. The average values by sector and strate were elaborated by means of NAKKEN & DOMMASSNES method (1975). Table I summarizes the cruise characteristics.

SURVEY	TIME	ECHOSOUNDER+ ECHOINT.	GEAR OPENING	SURVEYED AREA(nm²)	TRACK MILES
1982	May	EK-400+QD	10 m	2890	795
1983	Sep-Oct	EK-400+QD	10 m	12504	1837
1984	Oct-Nov	EK-400+QD	10 m	16727	2177
1985	Oct	EK-400+QD	10 m	12504	1550
1987	Jul	EK-400+QD	10 m	9327	1628
1988	May-Jun	EK-400+QD	10 m	16199	3610
1990	Oct-Nov	EK-500	10 m	16163	3236
1991	Oct-Nov	EK-500	20 m	14352	2845
1992	Oct-Nov	EK-500	20 m	16199	3140
1993	Oct-Nov	EK-500	20 m	10709	1885

Table I. Acoustics surveys in Spanish Mediterranean shelf.

After 10 years, the method has been fully standardized and has therefore produced a time series of sardine and anchovy abundances comparable over the last years. The results of the evaluations (biomass) and the catches in these years are as follows :

SARDINE	1982	83	84	85	86	87	88	89	90	91	92	93
BIOMASS *(1000 TM)*	105(1)	109	419	174	—	273(2)	182	—	175	227	455	322(3)
CATCHES *(1000 TM)*	36	43	35	45	47	40	41	39	38	45	50	46

(1) Understimated, Valencia and Cataluña not surveyed
(2) Understimated, Cataluña not surveyed
(3) Understimated, Vera and Alicante not surveyed.

These data suggest a lack of pressure on this stock, which is probably due to low market demand. According to this, catches could be considered independent of existent biomass.

ANCHOVY	1982	83	84	85	86	87	88	89	90	91	92	93
BIOMASS *(1000 TM)*	60(1)	47	44	—	—	4(2)	28	—	34	24	23	18(3)
CATCHES *(1000 TM)*	50	38	25	12	16	14	20	17	17	20	19	17

This species is the target of the purse seiner fleet, and its commercial value is much higher than the sardine one. The table shows a high fishing exploitation in accordance with this high demand.

REFERENCES

ABAd, R., J. MIQUEL and M. MILLÁN. 1991. Resultados de la campaña de evaluación acústica ECOMED 90 (22 Octubre-22 Noviembre 1990). *Inf. Téc. Inst. Esp. Oceanogr.*, 104 : 63 pp.
ABAD. R., J. MIQUEL, M. MILLÁN and M. IGLESIAS. 1992. Resultados de la campaña de evaluación acústica ECOMED 91 (21 Octubre-21Noviembre 1991). *Inf. Téc. Inst. Esp. Oceanogr.*, 131 : 77 pp.
ALVAREZ, F., X. PASTOR, P. OLIVER & J. MIQUEL. 1983. Resultados de la campaña de evaluación acústica "MEDITERRANEO 83".
MIQUEL, J., J. BRUNO, R. ABAD & A. GIRALDEZ. 1987. Informe preliminar de la campaña de evaluación de stocks de peces pelágicos "MEDITERRANEO 87".
MIQUEL, J. & R. ABAD. 1988. Informe preliminar de la campaña "ECOMED 88".
NAKEN, O. & A. DOMMASSNES. 1975. The application of an echointegration system in investigations on the stock stregth of the Barents sea capelin (Mallotus villosus) 1971-1974. ICES CM/B : 25.
OLIVER, P., X. PASTOR, F. ALVAREZ AND A. ASTUDILLO. 1982. Acoustic assessment of the coastal pelagic fish stocks of the Spanish Alboran Sea, with special attention to the sardine (May 1982). C.G.P.M. Tech. Consult. Acoust. Meth. Fish Detect. & Abund. Estimat.
OLIVER, P. & F. ALVAREZ. 1984. Estimación por métodos hidroacústicos de la biomasa de peces pelágicos costeros del Mediterráneo español (Octubre 1984).

ACOUSTIC ESTIMATION OF VOLUME AND DISTRIBUTION OF *APHIA MINUTA* (PISCES: GOBIIDAE) IN ALCUDIA BAY (MAJORCA ISLAND, SPAIN)

M. IGLESIAS, J. MIQUEL & F. ALVAREZ
Centro Oceanogràfico de Baleares, IEO, Spain

A specialized fishery directed at pelagic gobiids is conducted off Majorca island during wintertime. The target species is the transparent goby (*Aphia minuta*, Risso 1810) and by-catch species are *Pseudaphia ferreri* and *Cristallogobius linearis* (IGLESIAS & MARTORELL, 1988). The main catches are taken into the bays; Alcudia Bay is the area where most of the fleet work. The importance of this fishery is due to the local appreciation and high market value of transparent goby.

The fishery is directed at the aggregations that these pelagic gobiids form near the bottom during its reproduction time, being shoals detected with the aid of fish finders. This characteristic allows the use of acoustic methods to determine its localization and abundance.

This study has been the first time that acoustic methods have been used to evaluate *Aphia minuta* abundance and distribution.

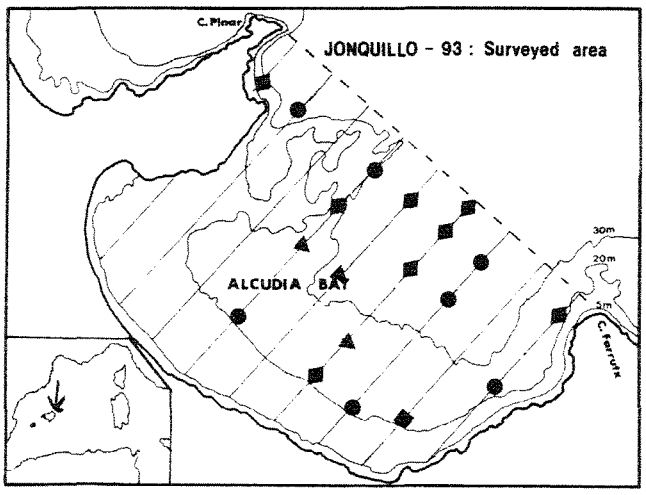
In January 1993, "Jonquillo-93" acoustic survey was carried out on R/V "Xarifa", a 7 m long, 9,9 HP boat, covering the area between Cape Pinar and Cape Farrutx (Alcudia Bay, figure I). A Skipper 815 paper echosounder with a towed body was used for data collection, using as the log interval one nautical mile. The survey consisted of nine tracks going from 5 meters depth near the coast to the mouth of the Bay (figure I). The number of nautical miles tracked was 54 and the covered area comprise 47.48 mn^2. The distance between tracks was one nautical mile.

Aphia minuta records on paper echosounder were identified by means of fishermen aid. The scrutinizing of echograms were made by four differents groups. Only the coincident readings were considered. The stock size of *Aphia minuta* was estimated by the method of enumeration and volume estimation of shoals recordings (FORBES & NAKKEN, 1972). A simply enumeration of number of shoals by nautical mile give a first relative index of abundance of this species in the area. Since size of shoals is very different, the estimation improves if we consider its volume.

Aphia minuta was abundant in January 1993 in Alcudia Bay with a total volume estimate of 12.902.751,44 m^3. This result agrees with the catches obtained during the fishing period 1992-1993. The distribution of *Aphia minuta* was related to depth and type of substrate, the shoals were concentrated on the center of the Bay where the bottoms are mainly flat rocks and sand. Also this area is characterized by clean waters. Shoals have been detected from 8 to 45 meters depth, being more abundant between 30 and 35 meters depth (65%). Volume of shoals runs from 12,7 - 84077,4 m^3, with the more abundant volumes between 0-1000 m^3 (60/%), followed by volumes between 1000-10000 m^3 (34%), 10000-50000 m^3 (3,4%) and bigger than 50000 m^3 (3%).

The acoustic evaluation of *Aphia minuta* by means of an echosounder has shown to be a valid method to determine its abundance and distribution. Further improvements of the method would require to use an echointegration method and to determine the TS (target strength) value of the species, which may allow to determine number and biomass of the species.

Figure I. Tracks survey and distribution of *Aphia minuta* in Alcudia Bay in January 1993



▲ 0- 1 000 m^3 ◆ 1 000 - 10 000 m^3
● 10 000- 50 000 m^3 ■ > 50 000 m^3

REFERENCES

FORBES, S.T. & O. NAKKEN, 1972. Manual de métodos para el estudio y la evaluacion de los recursos pesquerows. Parte 2. Utilizacion de instrumentos ac£sticos para la localizacion de peces y la estimacion de su abundancia. Manual de la FAO de Ciencias Pesqueras n° 5. FIRM/M5.
IGLESIAS, M. & J.M. MARTORELL, 1998. La pesqueria litoral de las Islas Baleares. proyecto cooperativo IEO/CAIB/CEE. XIVB1/87/8/2840. 199 pp.

V

W NIDAMENTAL GLANDS AND MATURITY STAGES IN ILLEX COINDETII (MOLLUSCA: CEPHALOPODA) OF THE STRAIT OF SICILY (CENTRAL MEDITERRANEAN)

Patrizia JEREB and Sergio RAGONESE

Istituto di Tecnologia della Pesca e del Pescato (ITPP). C.N.R.
Mazara del Vallo, Italia

Nidamental glands play a master role in squid reproduction (O'DOR and BALCH, 1985; ARKHIPKIN, 1992) and their macroscopic condition is used as an additional parameter to characterize different maturity stages (see JUANICO, 1983 for a review of maturity scales). Nidamental gland length (NGL) in particular proved to be a good indicator of maturity in *Illex illecebrosus*, when related with mantle length (ML) (Durward *et al.*, 1979). Nidamental gland index (NGI=NGL/ML) was often used afterwards to characterize maturity stages of several squid species (SANCHEZ, 1981; VILLANUEVA and SANCHEZ, 1989; HATFIELD and RODHOUSE, 1992). Here the relationship between NGL and ML, and the use of NGI and a three-stages macroscopic maturity scale referred to Illex coindetii (VERANY, 1837) of the Strait of Sicily is described.

Data come from two years of experimental trawl surveys carried out with seasonal periodicity in the Strait of Sicily (Central Mediterranean) (Levi, 1990). Within a study on the biology of *Illex coindetii*, a macroscopic maturity scale of three stages (1=immature; 2=maturing; 3=mature) was prepared (JEREB and RAGONESE, 1994). NGL (mm) and ML (cm, 0.5) were then related on a subsample of 1996 squid and the relationship analyzed. NGI (NGL/ML x 100) was computed for each maturity stage.

		Nidamental Gland Index				Log_e linear coefficients		
Mat	N	min	max	mean	s.e.	a	b	MSE
1	1073	5.7	39.2	13.3	0.1	-0.980	1.531	0.067
2	248	13.1	54.9	30.6	0.5	----	1.405	0.067
3	675	31.9	71.5	51	0.2	1.886	0.906	0.012
All	1996	5.7	71.5	28	0.4	-3.906	2.880	0.163

Tab. 1 - Descriptive statistics and regression results

The values of nidamental gland indices for each maturity stage are reported in Tab.1. Although a certain amount of overlapping among the different stages does occur, as expected, the scale seemed to work out rather adequately the separation of immature, maturing and mature females, considering the mean values corresponding to each stage. As for the NGL-ML relationship (Fig.1), this clearly showed differences in NGL increments during the different maturity stages. After an initial phase in which the relationship is positively allometric (b>1; stage 1 and 2), even though at a different rate, NGL increments become negatively allometric (b<1; stage 3). Therefore results of the analysis without considering the three stages separately does not give satisfactory results.

Providing that every classification of sexual maturity into stages imposes artificial discontinuities onto what is a continuous process, it is likely that each macroscopic maturity stage will include a broad range of body size and indices of maturity. This considered results obtained were satisfactory and NGI proved to be a good indicator of maturity also for *Illex coindetii* of the Strait of Sicily, once a maturity scale is provided and tested. NGI values obtained in the present case are close to those obtained for *Illex coindetii* of the Catalan Sea (SANCHEZ, 1981), thus supporting the possibility to apply results obtained for the same species also in different areas. Considering that all mated females (spermatophores inside the mantle cavity) were mature, spermatophores presence could be an additional factor to better discriminate between stage 2 and 3 and mating could be the trigger responsible for the differences in the nidamental gland develop-ment. NGL in fact increases with maturity, but the rate of the increment proved to be different in different maturation phases and this variation could follow different patterns in different species. In the present case NGL-ML relationship changes twice during the maturation process. The analysis of this relationship on the base of the maturity scale proposed allowed a better interpretation of the maturation process. It seems therefore that the use of the proposed macroscopic maturity scale and NGL, ML and the notation of the presence/absence of spermatophores (all measurements easily obtained in the field) will provide consistent information to discriminate basic maturity stages in *Illex coindetii* of the Strait of Sicily for fisheries managment purposes.

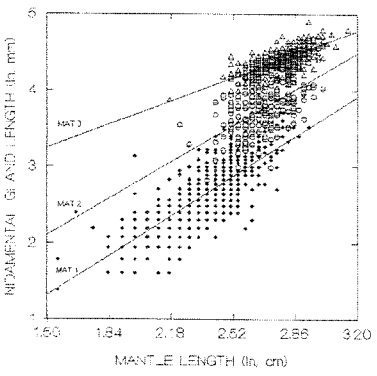


Fig. 1 - NGL- ML log-log relationship

REFERENCES

ARKHIPKIN, A., 1992. Reproductive system structure, development and function in cephalopods with a new general scale for maturity stages. *J. Northw. Atl. Fish. Sci.*, 12: 63-74

DURWARD, R.D., AMARATUNGA, T. and O'DOR, R.K., 1979. Maturation index and fecundity for female squid *Illex illecebrosus* (LeSueur, 1821). *ICNAF Res. Bull.*, 14: 67-72

HATFIELD, E. and RODHOUSE,P., 1992. Production of soma and gonad in maturing female Illex argentinus (Mollusca: Cephalopoda). *J. mar. biol. Ass. U.K.*, 72: 281-291

O'DOR , R.K. and BALCH, N., 1985. Properties of *Illex illecebrosus* egg masses potentially influencing larval oceanographic didtribution. *NAFO Sci. Coun. Studies*, 9: 69-76

JEREB, P. and RAGONESE, S., 1994. An outline of the biology of the broadtail shortfin squid *Illex coindetii* in the Sicilian Channel (Central Mediterranean). Submitted to *J. mar. biol. Ass. U.K.*

JUANICO, M., 1983. Squid maturity scale for population analysis. In: Advances in assessment of world cephalopod resources (p. 341-378), Caddy, J.F. (ed.), FAO Fish. Tech. Pap., 231: 452 p.

LEVI, D., 1990. Sessione valutazione risorse demersali. Relazione sull'attivit‡ svolta dall'Unit‡ Operativa Istituto di Tecnologia della pesca e del Pescato - Mazara del Vallo. N.T.R.-*I.T.P.P., 15 bis*

SANCHEZ, P., 1981. Caracteristicas bioecologicas de *Illex coindetii* (Verany, 1837) en el Mar Catalan. Ph.D. Thesis, University of Barcelona, 219 pp.

VILLANUEVA, R. and SANCHEZ, P., 1989 - Some data on the biology of the squid Todarodes angolensis (Cephalopoda: Ommastrephidae) in Namibian waters. *ICNAF Sel. Pap.*, 1: 17-22.

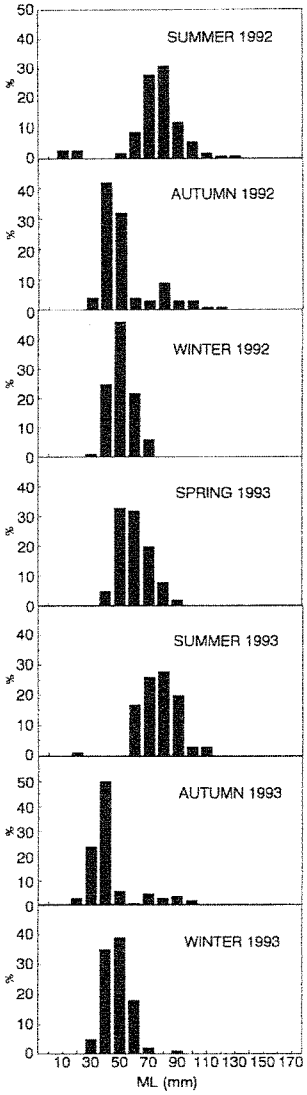
DISTRIBUTION, GROWTH AND MATURITY OF *ELEDONE CIRRHOSA* (CEPHALOPODA : OCTOPODA) IN THE THRACIAN SEA (EASTERN MEDITERRANEAN)

E. LEFKADITOU[1] and C. PAPACONSTANTINOU[2]

[1]Teuthis, Keramikou 62-64, 10435 Athens, Greece
[2] National Centre for Marine Research,16604 Helliniko, Athens, Greece

The horned octopus *Eledone cirrhosa* (Lamarck, 1798) is a benthic species quite common throughout the Mediterranean Sea, as also in the coasts of N.E. Atlantic and the North Sea. The population of *Eledone cirrhosa* was sampled over a total of 5862 km, between 22-416 m of depth. Seven seasonal trawl surveys were carried out the summer (June), autumn (September) and winter (late Novemmber - early December) in 1992 and 1993, and in spring (March) 1992. The area under investigation was subdivided into 4 depth strata: 0-50 m, 50-100 m, 100-200 m, >200 m; the hauls were proportionally distributed in the respective areas and positioned randomly.

Eledone cirrhosa was captured between 44-315 m and more frequently between 50-200 m. In autumn recruits (ML: 20-60 mm) are most abundant betwween 50-100 m, whilst larger individuals were caught mainly beyond 100 m. Size distribution ranged between 20-155 mm for females and 15-111 mm for males. The seasonal length frequency distribution (Fig 1), showed the presence of two or more cohorts in the catches of summer and autumn whilst in winter and spring it was possible to single out only one cohort to be followed over a period of two more seasons. The progression in modal size indicated growth rates of 10-20 mm per season, slowing down for bigger individuals. The recruits (ML: 20-60 mm) were already present in summer, but represented a higher proportion of the catch in the autumn sample. The low presence of larger animals (ML > 70 mm) in autumn, and their disappearence from the catches in winter,probably is due to high post-spawning mortality (MANGOLD- WIRTZ, 1963; BOYLE, 1983; BELCARI et al. 1990). In summer and autumn 1992, a third cohort, consisted of the largest specimen (ML > 100 mm), is doubtful. These individuals are probably slower-growing ones, which did not mature in the second year but overwintered as immature adults and contributed to the spawning population of he third year. Similar observations have been made in the *Eledone cirrhosa* growth model proposed by BOYLE (1983).



Least square regression equations were calculated from the logarithmically transformed mantle length (ML mm) and body weight (W gr) data, for each sex. The constants a and b in the resulting power functions- $W = aML^b$ - are :

females : a = 0.002615, b = 2.506, r = 0.93
males : a = 0.003358, b = 2.432, r = 0.91

The mantle length-weight relationship for females and males were not significantly different.

The VON BERTALANFY growth-parameters, estimated according to the SRLCA method (SHEPERD, 1987a), are :

MLinf = 240 mm, K = 0.34, to = 0.27

According to the above estimates, the largest mantle length observed (ML = 155 mm) corresponds to a three years old individual. However the group of largest individuals (ML > 100 mm), as it seems from the seasonal length frequency distribution, is poorly represented, which means that horned octopus usually matures, spawns and dies before reaching the age of two years (ML : 109 mm), an inference that is in accordance with the available references on the species. The maturity stages of *Eledone cirrhosa* were determined according to LIPINSKY'S scale (1979). The reproduction of *Eledone cirrhosa*, seems to start in early summer and last till mid of autumn,since mature males and females were observed during these seasons. Males were found to reach maturity earlier than females.

REFERENCES

BOYLE P.R.,1983. *Eledone cirrhosa*. In Cephalopod life cycles.1: 365-386.

BELCARI P.,FEDI E. & P.SARTOR.,1990. Analysis of the sexual developement of Eledone cirrosa (Cephalopoda, Octopoda) in the Northern Tyrrhenian Sea through two maturity indices. *Rapp.Comm.int.Medit.* 32.1:241

LIPINSKY M.,1979. Universal maturity scale for the commercally-important squids (Cephalopoda: Teuthoidea). The results of maturity classification of the Illex illecebrosus (LeSueur,1821) populations for the years 1973-1977. ICNAF Res.Doc.79/2/38, Serial 5364: 40 p.

MANGOLD K.,1963. Biologie des Cephalopodes benthiques et nectoniques de la Mer Catalanc. *Vie Millieu*, Supl.13: 285 p.

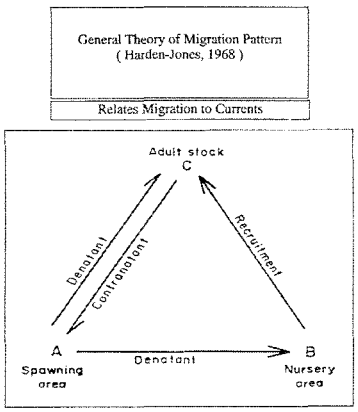
SHEPERD J.G.,1987a. A weakly parametric method for the analysis of length composition data. In PAULY D. & G.R.MORGAN (eds). ICLARM Conf.Proc., 13: 113-119.

V

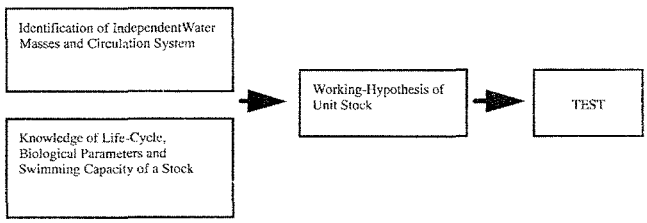
INDEPENDENCE OF WATER MASSES AND INDEPENDENCE OF STOCKS

Dino LEVI[1], M.G. ANDREOLI[2] & Pietro RIZZO[1]

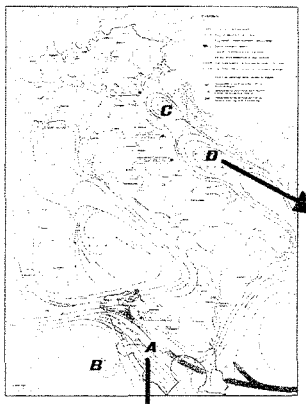
[1] Istituto di Tecnologia della Pesca e del Pescato, CNR ,Mazara del Vallo (TP), Italy
[2] Istituto di Istologia, Università di Palermo, Via Archirafi, 18, 90123, Palermo, Italy



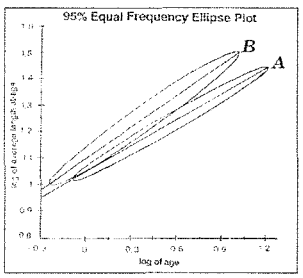
Flow-Chart of Hypothesis formulation and Testing



Identification of Independent Water Masses and Circulation System

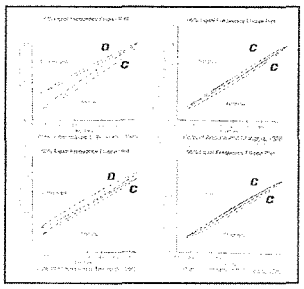


RED MULLET
Channel of Sicily



A POSSIBLE TEST

ANCHOVY
Adriatic Sea



SOME MAJOR REFERENCES

GHARBI, H. & M.H. KTARI, (1981).
Croissance des rougets en Tunisie. Bull. inst. nat. Sci. Tech. Oceanogr. Peche, Salambo, 8 : 5-40

GRANCINI, G., A. LAVENIA AND F. MOSETTI, (1972).
A contribution to the hydrology of the strait of Sicily. In Oceanography of the Strait of Sicily. Saclantcen Conference Proceedings N°7. pp. 68-81.

HARDEN-JONES, F.R. (1968).
Fish migration: 325 pp.
Edward Arnold (Publishers) Ltd, London.

LEVI, D. (1978).
A summary report on the routine sampling programme for sardine and anchovy in the Adriatic. FAO rapport de la Septieme Session du Group de Travail sur l'evaluation des ressources et les statistiques de peche du Conseil General des Peches pour la Mediterranée (CGPM). FAO-Rapports sur les peches n°; 204; pp. 115-117

LEVI, D., M.G. ANDREOLI & P. RIZZO. (1990).
Growth curves from representative samples of fish populations as possible hints for the identification of unit stocks. The case-study of red-mullet from the Sicilian Channel. In Marine Eutrophication and Population Dynamics. Proceedings of the 25th EMBS. Editors: Giuseppe Colombo et al. Published by Olsen & Olsen, Fredensborg, Denmark, pp. 299-305.

MOSETTI, F. (1989).
Mari. In Atlante Tematico d'Italia. Touring Club Italiano, Consiglio Nazionale delle Ricerche. 15.

ZORE', M. (1956).
On gradient current in the Adriatic Sea. Acta Adriatica vol. VIII, n°6636 pp.

MORPHOLOGICAL FEATURES OF THE BARBELS IN *MULLUS SURMULETUS* AND *MULLUS BARBATUS*

A. LOMBARTE and H. AGUIRRE

Institut de Ciències del Mar (CSIC) P. del Mar s/n 08039, Barcelona, Spain

Mullus barbatus and *Mullus surmuletus* are two very important species in the fisheries of the Catalan coast (NW Mediterranean), (MARTIN, 1991). *M. barbatus* is found on muddy bottoms while *M. surmuletus* mainly lives on rocky areas, even though both species have distributions with a considerable overlap. The study of their sensory structures, specially the barbels, could bring new data about their adaptation to the trophic resources in each substratum and the way these species share the same resource.

The ultrastructure of the barbels surface was observed in specimens from the two species of *Mullus* (between 13 and 22 cm of total length), using SEM standard procedures, usually employed in the study of sensory cells (DALE, 1976; KOTRSCHAL, 1992).

The surface of the barbels are fully covered by sensory pores (Fig. 1, 2). The structure of these pores is similar to other free chemoreceptors which are found in many groups of teleostean fishes (JANSSEN, 1990; KOTRSCHAL, 1992). The great abundance of chemoreceptors suggests a high sensibility of the barbels in front to the chemical stimulus. The lack of neuromasts indicates a secundary importance of the mechanical stimulus.

The two species are well differentiated in the density and distribution of the chemoreceptor cells. However, the pore ultrastructure is very similar in both species.

M. surmuletus has sensory cells sparsely distributed along the surface of the barbel. Usually they are isolated or found in little groups (2 or 3 cells) (Fig. 1a, 1b). The mean pore density is 15.4 SC/100.000 μm^2.

M. barbatus has sensory cells found in well defined groups. The number of pores by group oscillates between 5 or 9. (Fig. 2a, 2b). Their mean density is 26.8 SC/100.000 μm^2.

A higher density of sensory cells and more complex structure in *M. barbatus* should be related with a higher sensibility of their barbels to chemical stimulus than in *M. surmuletus*. Since the barbels are used to search preys (UIBLEIN, 1991), a greater sensibilty in *M. barbatus* could be an improvement to locate their prey in muddy bottoms, were the visibility lower than in the rocky zones.

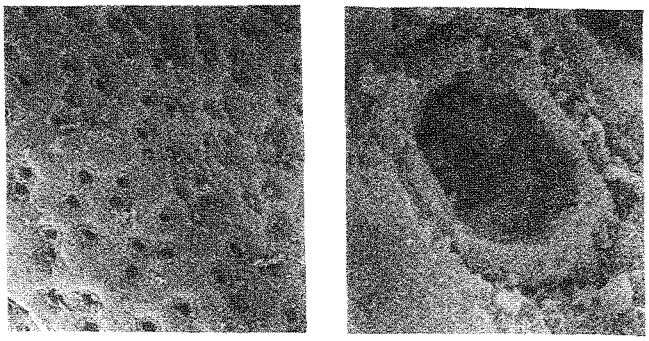


Fig. 1. Ultrastructure of the surface of the barbels in *M.surmuletus* . a: distribution of the sensory cells; scale bar, 200 µm. b: ultrastructure of a free neuromast; scale bar, 60 µm.

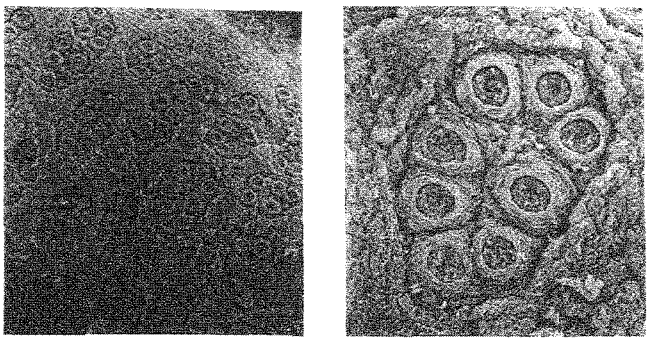


Fig. 2. Ultrastructure of the surface of the barbels in *M. barbatus* . a: distribution of the sensory cells; scale bar, 200 µm. b: Detail of a group of neuromasts; scale bar, 20 µm.

REFERENCES

DALE, T. 1976. The laberinthine mechanorrecepter organs of the cod *Gadus morhua* L. (Teleostei: Gadidae). *Norw. J. Zol.* 24 : 85-128.

JANSSEN, J. 1990. Localization of substrate vibration by the mottled sculpin (*Cottus bairdi*). *Copeia* (2) : 349-355.

KOTRSCHAL, K. 1992. Quantitaitive scanning electron microscopy of solitary chemoreceptor cells in cyprinids and other teleosts. *Env. Bio. Fish.* 35 : 273-282.

MARTIN, P. 1991. La Pesca en Cataluña y Valencia (NO Mediterrneo): analisis de las series historicas de captura y esfuerzo. *Inf. Téc. Sci. Mar.* 162 : 3-43.

UIBLEIN, F. 1991. Ontogenetic shifts in resource use and shoaling tendency related to body size in red sea goatfish (*Parupeneus forsskali*, Mullidae). 12 : 153-161.

V

EFFECT OF A TWO MONTHS CLOSED SEASON ON MONTHLY CATCHES OF HAKE (*MERLUCCIUS MERLUCCIUS*) AND RED MULLET (*MULLUS* SPP) IN A RESTRICTED AREA OFF THE CATALAN COAST (NW MEDITERRANEAN)

Paloma MARTIN

Instituto de Ciencias del Mar. CSIC. Barcelona, Spain

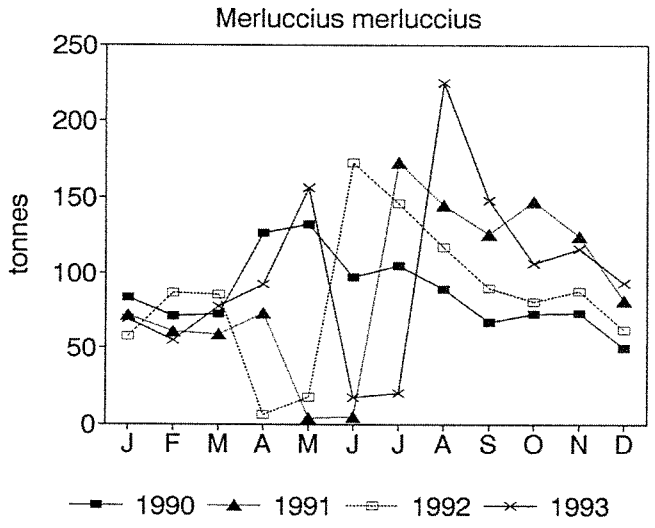
Hake (*Merluccius merluccius*) and red mullet (*Mullus* spp) are two of the most valuable fishing resources off the Catalan coast. Monthly catches of these two species undergo seasonal variations, specially marked in the case of the red mullet. During the year, highest hake catches are obtained by late spring and early summer, while highest red mullet catches correspond to late summer and autumn.

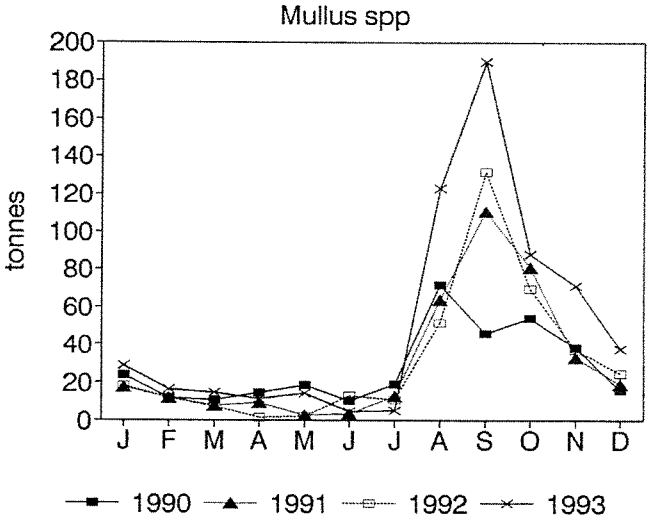
The trawling fleet operates five days a week, a maximum of 12 hours at sea per day. As an additional fishing regulation, from 1991 a closed season of a duration of two months was implemented in the southern third of the littoral. This closure affects about 200 vessels (57 000 hp) based in five fishing ports, which represents half of the trawl fleet. The period of closure is not the same every year : May and June in 199, April and May in 1992, June and July in 1993.

In the hake, highest catches were obtained during the three or four months from the opening of the activity of the trawling fleet after the closure. These months changed depending on the closed season period, the maximum monthly yield corresponding to the month following the end of the closure (July in 1991, June in 1992 and August in 1993). In the red mullet, the time of the year with highest catches was the same during 1990-1993, although the values of the maximum monthly catches were higher in the years with closure.

Both in the case of hake and in the red mullet, monthly catches after that time of the year when highest values are attained have remained at a level similar to that of 1990, year preceding the implementation of a closed season for trawling. In January 1994, hake and red mullet catches were similar to those of the four previous years. Also, it has not been observed a clear tendency of increasing hake and red mullet annual catches from 1990. Apparently, the result of the closure has been to concentrate the catches in a few months just after the closed season rather than bringing a sustained increase of catches during the whole year.

Part of the information used in this study was collected within a research project on trawling financed by the Generalitat de Catalunya (Contract Ref. PCC 300 12/90).





MAPPING AND ASSESSMENT OF ANCHOVY (*ENGRAULIS ENCRASICOLUS*) EGG PRODUCTION BY GEOSTATISTICS

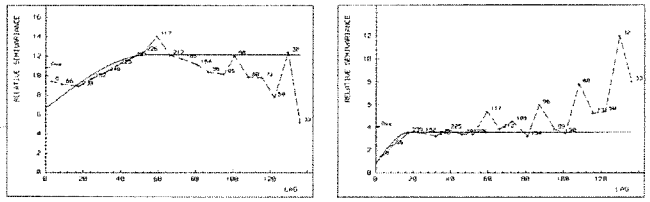
Francesco MAYNOU[1] and Isabel PALOMERA[2]

[1] Gulf Fisheries Centre, Dept.. Fisheries & Oceans, Moncton, Canada
[2] Institut de Ciències del Mar, Plaça del Mar, s/n. E-08039 Barcelona, Spain

An anchovy egg sampling survey was carried out on the Catalan Sea shelf (Eastern Spain) from 27 to 31 May 1990. The experimental survey was planned within the Anchovy stock assessment project (PALOMERA and PERTIERRA, 1993). The survey comprehensively encompassed the spawning area and horizontal and vertical range known from previous work in the study area (PALOMERA, 1991, 1992). Details of the sampling scheme and sampling gear used can be found in PALOMERA and PERTIERRA (1993). Eggs were counted and assigned to a development stage according to the scales of REGNER (1985) and MOSER and AHLSTROM (1985).

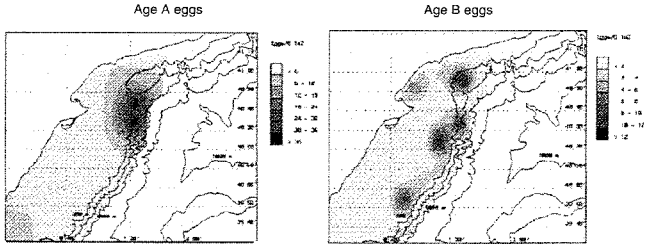
In order to accurately map and further estimate the density of eggs at ages A and B (LO, 1985), geostatistical methods were applied (MATHERON, 1971; JOURNEL and HUIJBREGTS, 1978). The linear geostatistical method here employed is a two stage optimal interpolation technique. First, the spatial structure of dependence is determined by a spatial autocovariance function, in our case-study, the semivariogram. Experimental semivariograms were computed for eggs at ages A and B and revealed a structure of spatial dependence which increased progressively to 55 km for age A eggs and 19.5 km for age B eggs and then stabilized around the sample variance (figure 1). In order to proceed to the actual mapping or spatial prediction stage, the experimental semivariogram must be modeled by a theoretical semivariogram function which complies with certain mathematical conditions (MATHERON, 1971). Both for eggs at ages A and B, a spherical model was fitted, including a relatively high "nugget" term which represents micro-scale variability and white-noise or sampling error. The mapping was conducted by estimating the density of eggs at ages A and B over an arbitrarily fine grid on the polygon defined by presence of eggs. The (linearly) optimal interpolator is obtained solving the point kriging system of linear equations at each point of the grid. The results for eggs at ages A and B is presented in figure 2.

Figure 1: Experimental semivariograms and spherical fit.



The geostatistical technique further allows to estimate the global number of eggs over a polygon (regular or irregular) by block kriging (MATHERON, 1971; JOURNEL and HUIJBREGTS, 1978). The kriging variance obtained by solving the kriging system is used to give confidence limits to our estimates. The total number of eggs at ages A and B were $5.63*10^{11}$ $6.32*10^{11}$ and $1.41*10^{11}$ $0.74*10^{11}$, respectively. Linear geostatistics was successfully applied to describe the structure of spatial depence of anchovy eggs in the spawning area off the Catalan coast, as well as to map its distribution and to obtain global estimates which take into account the spatial autocorrelation among samples. Given the short duration of the survey (4 days) the maps give a punctual picture of the distribution of anchovy eggs -and therefore, of the parental stock- at a population level (SMITH and HEWITT, 1985.) Age A eggs are mainly centered in front of the Ebro river delta, near to the shelf break. Age B eggs show quite a different pattern "moving off" the main age A eggs center in 3-4 high-density patches some 20 km in diameter (of the same order of magnitude as the range of the fitted semivariogram function). This distribution pattern could be explained in terms of dispersal by the water masses.

Figure 2: Kriging maps for eggs age A and B.



REFERENCES

JOURNEL, A.G. and HUIJBREGTS, C.J. 1978. *Mining Geostatistics*. Academic Press.

LO, N.C.H. 1985. A model for temperature-dependent Northern anchovy egg development and an automated procedure for the assignment of age to staged eggs. *In:* R. Lasker (ed.): An egg production method for estimating spawning biomass of pelagic fish: Application to the Northern anchovy, *Engraulis mordax*. U.S. Dep. Commerc., *NOAA Tech. Rep.* NMFS 36, pp. 43-50.

MATHERON, G. 1971. The theory of regionalized variables and its applications. *Cahiers du Centre de Morphologie Mathématique* de Fontainebleau. Fascicule 5.

MOSER, H.G. and AHLSTROM, E.H. 1985. Staging anchovy eggs. *In:* R. Lasker (ed.) : An egg production method for estimating spawning biomass of pelagic fish: Application to the Northern anchovy, *Engraulis mordax*. U.S. Dep. Commerc., *NOAA Tech. Rep.* NMFS 36, pp. 37-42.

PALOMERA, I. 1991. Vertical distribution of anchovy eggs and larvae in stratified waters of the Western Mediterranean. *Mar. Biol.*, 111: 37-44.

PALOMERA, I. 1992. Spawning of anchovy *Engraulis encrasicolus* in the Northwestern Mediterranean relative to hydrographic features in the region. *Mar. Ecol. Prog. Ser.*, 79: 215-223.

PALOMERA, I. and PERTIERRA, J.P. 1993. Anchovy biomass estimate by the daily egg production method in 1990 in the Western Mediterranean Sea. *Sci. Mar.* 57(2-3):243- 251.

REGNER, S. 1985. Ecology of planktonic stages of the anchovy, *Engraulis encrasicolus* (Linnaeus, 1758) in the central Adriatic. *Acta Adriatrica* 26(1):1-113.

SMITH, P.E. and HEWITT, R.P. 1985. Sea survey design and analysis for an Egg Production Method of Anchovy Biomass Assessment. *In:* R. Lasker (ed.): An egg production method for estimating spawning biomass of pelagic fish: Application to the Northern anchovy, *Engraulis mordax*, pp. 17-26. U.S. Dep. Commerc., *NOAA Tech. Rep.* NMFS 36.

V

DONNÉES RÉCENTES SUR QUELQUES MAMMIFÈRES MARINS ET SUR UNE TORTUE DES CÔTES MAROCAINES

MENIOUI M.[1], BERRAHO A.[2], IDELHAJ A.[2] et MOUMNI A.[2]

[1] I.S, BP 703 Rabat-Agdal et C.N.R., B.P. 8027, Rabat, Maroc
[2] Institut Scientifique des Pêches Maritimes, 2, Rue Tiznit, Casablanca 01, Maroc

Les mammifères et les tortues des côtes marocaines sont certainement parmi les moins étudiées à l'échelle de la Méditerranée et de l'Atlantique du Nord. Peu de travaux y ont été consacrés dont ALONCLE (1964, 1967 a et b) PASTEUR et BONS (1960), AVELLA et GONZALEZ (1984), BAYED et BEAUBRUN (1987), BEAUBRUN (1990) et El AMRANI *et al.* (1993). Cette note vise à fournir des données nouvelles sur certaines espèces :

- ***Megaptera novaeangliae*** Borowski, 1781. L'espèce était connue au Maroc par l'unique mention d'ALONCLE (1967 a) dans une mêlée, curieuse, de plusieurs espèces vue le 17-02-65 entre le Maroc et le banc de la Conception. Selon l'auteur "*sur 360°, aussi loin que pouvait porter la vue, des souffles et des animaux,..., globicéphales, tursions, dauphins, mégaptères.*" Le 27-09-93, un spécimen de 10,9 m. de long a échoué près de Kénitra (34°N 6°40W). Le 03-10, l'animal agonisait encore. Sa pectorale droite fracturée, il souffrait de brûlures de second degré. Selon des pêcheurs, il était encadré de deux autres cétacés de plus grande taille qui n'ont pris le large que lorsqu'il est venu se dessécher sur la plage. C'est à notre connaissance la première et seule fois que cette espèce, gravement menacée à l'échelle mondiale, a échoué sur la côte marocaine où elle a effectivement été identifiée.
- ***Balaenoptera acutorostrata*** Lacépède, 1804. Jamais cette espèce n'a été rapportée auparavant des eaux marocaines; seuls COUSTEAU et PACCALET (1986) parlaient d'un "*troupeau qui fréquenterait la zone comprise entre le Maroc et l'Ecosse pendant la période hivernale*". C'est en feuilletant un rapport du Ministère des Pêches Maritimes et de la Marine Marchande, que nous avons été retenus par la photographie d'un baleinoptère d'environ 6 m, avec une tâche blanche au milieu de la pectorale, caractéristique de l'espèce, qui avait été piégé et étouffé en août 1993 dans les filets d'un chalutier russe dans la région d'Eddakhla (23°45N 15°50W).
- ***Balaenoptera physalus*** Linné, 1758. Une des principales espèces pêchées dans le détroit de Gibraltar, elle n'a pas été rapportée des côtes marocaines depuis les années 60 (BAYED et BEAUBRUN, 1987). Le 28-02-93, un spécimen de 16,5 m. a été trouvé mort sur une plage près d'El Jadida (33°N 8°30°W).
- ***Physeter macrocephalus*** Linné, 1758. L'espèce était relativement abondante sur les côtes marocaines du détroit de Gibraltar surtout parce qu'elle suit, lors de sa migration vers la Méditerranée, la branche du courant atlantique longeant les côtes nord-africaines. Les échouements ne sont pas rares non plus; mais ils ont surtout été rapportés de la façade atlantique. Le dernier en date est celui d'une femelle de 9,80 m de long, échoué le 24-01-90, à 27 km au sud de Safi (32°N 9°15W), juste après l'accident du pétrolier iranien Kharg V au large du Maroc.
- ***Globicephala melaena*** Traill, 1809. Le globicéphale noir, plus fréquent dans le détroit de Gibraltar, a été signalé pour la dernière fois dans les eaux marocaines, il y a environ dix ans : 6 individus repérés près des îles Chaffarines (BAYED et BEAUBRUN, 1987). Le 15-04-91, à bord du navire de recherche américain Seward Johnson, nous avons vu un troupeau de huit individus, dont une jeune, au large du Cap des Trois Fourches (35°30N 3°W).
- ***Globicephala macrorhyncha*** Gray, 1846. Cette espèce, connue dans de nombreux points avoisinant les eaux marocaines, n'a jamais été signalée dans ces dernières. Alors que nous rédigions cette note, nous avons découvert dans les locaux de l'Institut Scientifique des Pêches Maritimes, deux crânes de globicéphales - dont l'un toujours exposé sous le nom de "*Globicephala malaoena*". Leur analyse montre qu'il s'agit indiscutablement de deux spécimens de *G. macrorhyncha*. Leurs pré-maxillaires, caractéristiques, sont élargies dans leurs moitiés distales et couvrent complètement les maxillaires.
- ***Souza teuszii*** Kunkenthal, 1892. Cette unique espèce du genre *Sousa* de l'Atlantique n'était connue que de certaines côtes africaines au sud de la Mauritanie. En 1990, BEAUBRUN la signale pour la première fois des côtes sud-marocaines; en 1993, 10 autres spécimens y sont rapportés (EL AMRANI et RAMDANI Com. Pers.); l'espèce ne montrait pratiquement que sa nageoire dorsale, caractéristique. L'espèce qui normalement ne constitue pas comme d'autres dauphins de grands troupeaux, s'est apparemment "acclimatée" aux eaux marocaines et y a même constitué des groupes sociaux.
- ***Tursiops truncatus*** Montagu, 1821. Espèce la plus rapportée des côtes marocaines, signalons juste son abondance ces derniers temps dans les parages de M'diq (35°30N 5°20W) où on peut l'observer pratiquement chaque jour. Le 30-09-93, une dizaine d'individus sont venus augmenter l'effectif de notre palanquée, lors d'un palier à 3 m, pendant près de cinq mn. Son abondance dans cette région serait due à des concentrations de mulets près des égouts et du port de pêche.
- ***Delphinus delphis*** Linné, 1758. Connue de longue date (1836) des côtes marocaines, cette espèce paraît plus abondante sur sa façade atlantique, surtout au sud d'Agadir (BAYED et BEAUBRUN, 1987). En 1990, au large de Casablanca (33°20N 7°40W), une vingtaine d'individus évoluait en plein milieu d'une nappe de pétrole provenant du pétrolier iranien Kharg V. Le 17-05-92, à bord du navire océanographique allemand Wega, nous avons observé au large de Casablanca, un troupeau de dauphins communs de plus d'une centaine d'individus qui ne semblaient préoccupés que par leur déplacement vers le nord. En mars 1994, deux autres spécimens ont échoué près de M'diq.
- ***Stenella coerulealba*** Myen, 1833. Espèce peu connue des côtes marocaines : deux observations en Méditerranée et dans le détroit de Gibraltar (BUSNEL *et al.* 1968); un échouement en Atlantique (BAYED et BEAUBRUN, 1987); en août 93, une dizaine d'individus vus au large de Tétouan.
- ***Orcinus orca*** Linné, 1758. L'espèce a été signalée pour la dernière fois en 1984 dans le détroit de Gibraltar (BAYED et BEAUBRUN, 1987); mais en 1991, on a vu de nombreux spécimens au large de la côte des phoques au sud du Maroc (EL AMRANI, Com. Pers.) et le 10-06-93, un jeune mâle a été remonté dans les filets d'un chalutier au nord de Cap Barbas (22°54N, 16°34 E).
- ***Monachus monachus*** Hermann, 1779. La population méditerranéenne du Maroc semble complètement éteinte. Le dernier recensement de 1991 dans le sud de la côte atlantique du Maroc fait état de 100 à 120 individus. A la fin de 1993, le Maroc a déclaré la côte des phoques, zone interdite à la pêche et à la navigation et a organisé en novembre, avec le Parc national français de Port-Cros, une campagne de recensement des phoques sur la côte sud-marocaine. Une vingtaine d'individus ont pu être observés dont un bébé-phoque mort, mais la mission n'a pu être achevée à cause de conditions climatiques défavorables.
- ***Dermochelys coriacea*** Vandelli, 1761. Pour cette espèce menacée dans toute son aire de répartition, signalons trois présences : dans la région de Mohammadia (33°30N 7°20W) en mars 93, dans les filets d'un chalutier le 28-04-93 au sud de Boujdour (26N 14°30W) et le 22-11-93 dans l'estuaire du Bou Regreg, à quelques kilomètres vers l'amont.

REFERENCES

ALONCLE H. 1964. Premières observations sur les petits cétacés des côtes marocaines. *Bull. Inst. Pêch. Mar.* Maroc. 12: 21-42
ALONCLE H. 1967a. deuxième note sur les petits cétacés de la baie ibéro-marocaines. *Bull. Inst. Pêch. Mar.*, Maroc. 15:33-3
BAYED A. et BEAUBRUN P.C. 1987. Les mammifères marins du Maroc. Inventaire préliminaire. *Mammalia*, 51: 437-446
BEAUBRUN P. Ch. 1990. Un cétacé nouveau pour les côtes sud marocaines, *Sousa teuszii* (Kukenthal, 1892) *Mammalia*. 54 (1): 162-164.
El AMRANI M., IDELHAJ A. et RAMDANI M., 1993. Circulation des eaux et pollution des côtes méditerranéennes du Maghreb. Chouikhi, Izdar et Menioui (eds). Publ. INOC 307 p.

DISTRIBUTION AND GROWTH PATTERNS OF A DEEP-SEA MEDITERRANEAN FISH: *ALEPOCEPHALUS ROSTRATUS*

Beatriz MORALES-NIN[1] & Enric MASSUTÍ[2]

[1] CSIC-Institut d'Estudis Avançats de les Illes Balears. Campus Universitari.
[2] IEO-Centre Oceanogràfic de Balears, Moll de Ponent s/nApdo. 291, 07080 Palma de Mallorca, Spain

Alepocephalus rostratus Risso, 1820 is the only Alepocephalidae innhabiting the Mediterranean. Although in this area it is one of the predominant species in the deep-sea fish communities (STEFANESCU *et al.*, 1992), its biology is scarcelly known. The present study aimed at examining the abundance and bathymetric trends of this species in the upper and middle slope, and at determining its growth patterns in the Northwestern Mediterranean.

A. rostratus was collected in the Catalan Sea, in six cruises on board the R/V "García del Cid": RETRO I (April'91), RETRO II (December'91), RETRO III (March'92), ZONAP 0592 (May'92), RETRO IV (July'92) and BATMAN (March'94). A total of 104 hauls were made between 147 and 1317 m depth, using semi-balloon otter-trawls. Its percentage of appearance in each cruise ranged from 33.3 to 67.9% of the hauls.

The total length (TL) of all specimens was measured to the nearest cm. In random subsamples the weight (TW) was determined to the nearest 0.1 g, and sagittae otoliths were extracted. Its maximum length (OL) were measured to the nearest 0.1 mm using a caliper, and they were weighed (OW) to the nearest 0.1 mg. Otoliths were read by the two authors, following standard techniques (MORALES-NIN, 1987), and only coincident interpretations were accepted. The length-weight relationships for fish and otoliths, and the correlation between fish length and otolith size, were calculated applying linear and exponential regression equations. The age-length relationship was calculated, and the von Bertalanffy growth function (VBGF) was fitted. Because there is no birth-date data on this species, the number of rings was considered as the age.

A. rostratus appeared in hauls below 600 m depth, and was mainly associated with depths greater than 1000 m. In the upper slope (12 hauls on 604 m mean depth) it was scarce : a total of 9 fishes with a biomass of 983 g were captured. It was abundant in the middle slope (12 hauls on 1 237 m mean depth), where 1425 fishes with a biomass of 287 220 g were caught. A total of 2 396 specimens between 1 and 45 cm were measured. Its average size increases progressively from 600 to 1000 m depth (Table I). It is due to the presence of the smaller (1-10 cm) and greater (39-45 cm) individuals from 600 to 1000 m and 1200 to 1300 m depth, respectively, while the other specimens were uniformly distributed along the whole range. In all cases the highest correlations were obtained using exponential regression, with a positive allometry in the weight growth of the specimens in relation to length. A negative allometry was found in the growth of otoliths, and in the relationship between fish length and otolith size. This implies a relative decrease of the otolith size with age.

Length	Depth-strata (m)						
cm	650	750	850	950	1050	1150	1250
Mean	35	32	38	4	42	23	2192
Range	1-10	3-26	8-38	4-35	11-38	20-37	11-45
x	7.77	10.59	20.47	22.18	25.07	28.87	28.79
std	8.50	5.61	8.85	7.14	6.39	4.83	5.50

Table I.- Length distribution by depth from 600 to 1300 m. Data were pooled for the six cruises, and 100 m depth intervals were considered.

The greatest age observed was 23 years, though this age-class and the age-classes oldest than 15 years are poorly represented in the population. A great percentage of individuals studied (until 50%) ranged from 7 to 12 years. The presence of many age-classes seems to be a common feature of all deep-sea fish populations (GAGE & TYLER, 1991).

Parameter	Estimate		std	Confidence limits
Linf (cm)	45	1,32	42,87	48,05
K (yr-1)	0,09	0,01	0,07	0,10
t0	-3,10	0,26	-3,61	-2,59

Table II.- VBGF parameters determined from the age-length relationship.

The parameters of the VBGF (Table II) and the growth curve (Fig. 1), obtained from the interpretation of the growth rings in otoliths, showed a low growth rate. This added to the population structure of this species, dominate by adult fish, its high maximum length, its longevity and its low fecundity (GOLOVAN & PAKHORUKOV, 1980), correspond to a typical k-type life history strategy. Although it is not by all means the general rule in the deep-sea organisms (GAGE & TYLER, 1991).

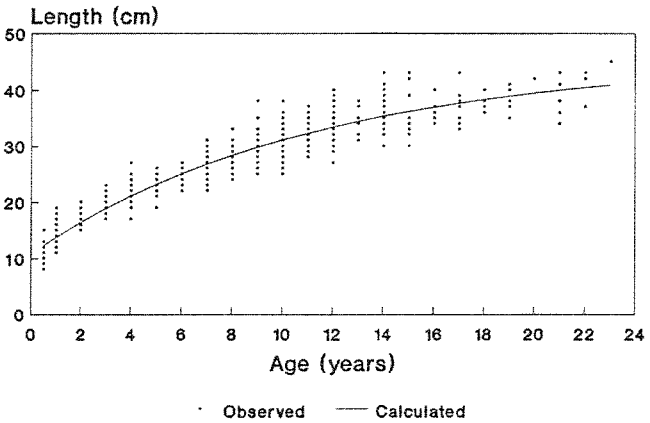


Fig. 1.- Age-length relationship and VBGF curve determined from otoliths.

ACKNOWLEDGEMENTS.- We are grateful to M.C. Iglesias for her help during the elaboration of the poster. This work was supported by the Spanish CICYT Projects RETRO (DGICYT, ref. MAR90-757), ZONAP (DGICYT, ref. PB90-0166) and BATMAN (AMB93/0283).

REFERENCES

GAGE J.D. & P.A. TYLER, 1991. Cambridge Univ. Press, G. Britain. 504 pp.
GOLOVAN G.A. & N.P. PAKHORUKOV, 1980. *J. Ichthyol.*, 20(3) : 77-83.
MORALES-NIN B., 1987. *Inf. Téc. Inv. Pesq.*, 143 : 1-30.
STEFANESCU C., D. LLORIS & J. RUCABADO, 1992.- *J. Nat. Hist.*, 26 : 197-213.

ABUNDANCE AND SIZE DISTRIBUTION OF *DIPLODUS VULGARIS* OF THE NATIONAL PARK OF THE CABRERA ARCHIPELAGO (BALEARIC ISLANDS) DURING SUMMER

J. MORANTA[1], J. COLL[2], O. REÑONES[1] and B. MORALES-NIN[2]

[1] Lab. de Biologia Marina, Univ. de les Illes Balears, 07071 Palma de Mallorca, Spain
[2] CSIC-Institut d'Estudis Avançats, Campus Univ., 07071 Palma de Mallorca, Spain

Diplodus vulgaris (E. Geoffroy Saint-Hilaire, 1817) is one of the littoral species which is catched by both sporting and small-scale fisheries. This work shows the size distribution and density of *D. vulgaris* in the waters around Cabrera National Park, where since 1991 only small-scale fishing has been permitted.

The following stations have been studied : 3 stations of rocky blocks at 5 and 25 m depth (RB1-3, photophilic algal community), 1 station at 40 m (SAC, sciaphilic algal community), and 2 stations of vertical cliffs (VC1-2, photophilic algal community) at 5 and 15 m. Quantitative estimates of abundance and size (accurate to 4 cm) of *D. vulgaris* were carried out in transects 100 to 210 m long by 10 m average width, using a visual census technique. Censuses were repeated for at least 5 consecutive days between June and August 1993 between 10.00 and 14.00 g.m.t. Size frequencies and depths at each station were compared using the similarity percentage index, using the VITMAN program (J. LLEONART, unpubl.). This index measures the area of intersection of distributions in relation to the area of their union. Biomass is calculated by applying values of the weight-length relationship derived from the literature (C.G.P.M., 1980) to the average frequencies by size class. The greatest abundance and biomass of *D. vulgaris* was obtained in the stations with the photophilic algal community blocks (Table 1). Amongst these, station RB3 showed the greatest abundance in shallow waters, probably due to the greater hydrodynamism of this area. The results obtained are similar to those of GARCIA-RUBIES and ZABALA (1990) for exposed zones located inside and outside the Medes Islands reserve. Maximum biomass values were obtained at the two depths of station RB3.

Stations	Abundance(S.E./C.L.95%)	Biomas(S.E.)
RB 1 (5 m)	26,11(20,76 - 32,8)	3000,0± 943,6
RB 1 (25 m)	25,03(18,88 - 30,5)	7729,2±1749,3
RB 2 (5 m)	9,91(5,11 - 18,3)	1423,4± 470,0
RB 2 (25 m)	46,94(33,12 - 66,7)	8086,1±2264,5
RB 3 (5 m)	103,58(72,96 -147,4)	17689,5±4861,8
RB 3 (25 m	69,10(33,12 -144,0)	11100,6±3012,6
SAC	4,15±0,91	590,5± 171,5
VC 1 (5 m)	3,72±0,49	306,9± 105,2
VC 1 (15 m)	2,35±0,66	190,5± 66,5
VC 2 (15 m)	6,50±1,39	381,7± 141,0

Table 1.- Abundance, biomass and standar error of *D. vulgaris* per 1000 m²

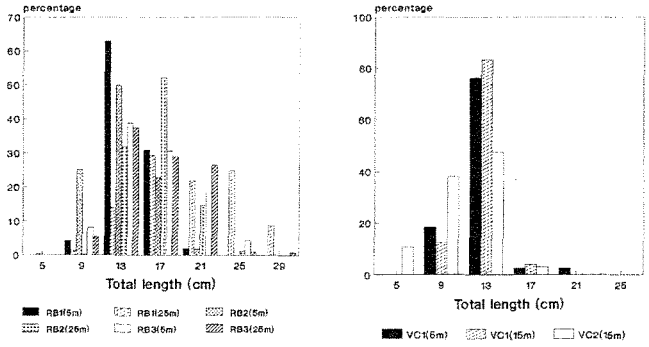


Fig. 1 and Fig. 2- Length of *D. vulgaris* in rocky block (Fig.1) and vertical cliffs (Fig. 2) with photophilic algal community.

The observed size ranges vary between 5 and 32 cm at those stations over photophilic algal community blocks, 5 and 20 cm at cliffs, and 12 and 25 cm over the sciaphilic algal community blocks (Fig. 1 and 2). With the exception of the 25-m-depth blocks of stations RB1 and RB2, modal size is between 13 and 16 cm. At 25 m, modal size is less homogeneous at stations RB1 and RB2. An increase in size was noted with depth, the mode being 17- 20 cm. Moreover, at station RB2, a second, less pronounced mode is seen at 25-28 cm size. Values of similarity index of size distribution are given in Table 2. The greatest similarity in size frequency appears between the two depth levels of stations 2 (0.91) and 3 (0.91). There is a general clear tendency for size increase with depth, both within the same station and throughout the study area.

	RB1(5	RB1(25	RB2(5)	RB2(25)	RB3(5	RB3(25)	VC1(5)	VC1(15)
RB 1 (25m)	0.47							
RB 2 (5m)	0.79	0.40						
RB 2 (25m)	0.65	0.59	0.57					
RB 3 (5m)	0.76	0.67	0.72	0.8				
RB 3 (25m)	0.73	0.68	0.67	0.77	0.91			
VC 2 (5m)	0.72	0.21	0.73	0.37	0.52	0.48		
VC 2 (15m)	0.71	0.19	0.66	0.36	0.51	0.47	0.91	
VC 3 (5m)	0.55	0.18	0.76	0.35	0.50	0.46	0.69	0.63
SAC 3	0.84	0.54	0.76	0.82	0.77	0.57	0.55	0.53

Table 2.- Similarity matrix of size distribution of *D. vulgaris* between differents stations and depht.

REFERENCES

GARCIA-RUBIES A. & ZABALA M. (1990). *Sci. mar.*, 54(4) : 317-328.
CGPM, 1980. Rapp. FAO Pêches, 227: 155 p.

ASPECTS ON THE BIOLOGY OF BLACKSPOT SEABREAM, *PAGELLUS BOGARAVEO* (BRUNNICH, 1768) IN THE NORTHERN AEGEAN SEA (GREECE)

Ch. MYTILINEOU and C. PAPACONSTANTINOU

National Centre for Marine Research, Ag. Kosmas 16604, Athens, Greece

Pagellus bogaraveo is a demersal fish, common in the western coast of the Atlantic Ocean and the Western Mediterranean, but quite rare in the Eastern Mediterranean or absent from the Black Sea (FISHER *et al.*, 1987). Although some works on the biology of the species in the Western Mediterranean and the Atlantic have been published (COUPE, 1954; RAMOS & CENDRERO, 1967; SANCHEZ, 1983; KRUG, 1989), no information is available from the Eastern Mediterranean and especially the Greek waters. A total of 5 271 individuals was collected seasonally from June 1992 to December 1993, by a 400HP commercial trawler equipped with a cod-end mesh size of 14 mm, in the Thermaikos Gulf, the Gulfs of Chalkidiki and the Thracian Sea (Greece). Fork length, weight and sex were recorded. Age was determined by otolith reading. FISHPARM (PRAGER *et al.*, 1989) was used for the estimation of von Bertalanffy growth parameters. The length-frequency diagram of the caught blackspot seabreams showed that fork lengths ranged from 70 to 175 mm (Fig.1). Since larger individuals are known to exist in the Greek waters (pers. observ.), the main bulk of the fished individuals, ranging from 90 to 140 mm, could be considered as representative of the young blackspot seabreams. Young-of-the-year were fished mainly in December, but they appeared in the trawl net until March. Blackspot seabreams were caught from 22 to 316 m of depth. The smaller individuals (<110 mm) were maily found in shallow waters (< 50 m) and near the mouth of the rivers, while the greater ones (>110 mm) in deeper waters (> 50 m).

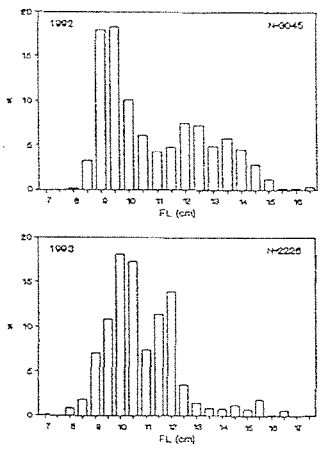


Fig. 1 Length-frequency distribution of *P.bogaraveo*

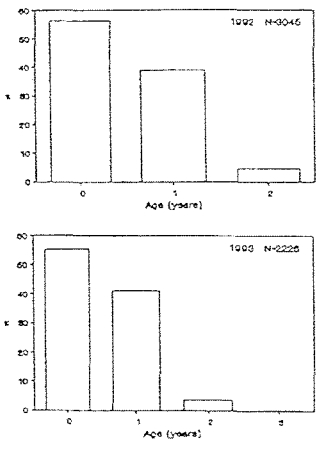


Fig.2. Age composition of *P.bogaraveo*

Otolith reading revealed 4 age groups, from age group 0+ to age group 3 (Fig. 2, Table 1). Otolith ring formation was considered to be annual. The examination of annual increment showed that the period of annulus formation was mainly in December, extending until March. The fork length-otolith radius relationship was found as follows : logFl = 0.702427 + 0.948959log R (N = 384, r = 0.96).

Mean lengths-at-age were estimated from the backcalculation (Table 2) using the following equation : logFln = logFl + 0.948959 (logRn - log R). Annual increament was found to be greater during the first year of life (Table 2).

Von Bertalanffy growth parameters (Floo = 251.2 mm, k = 0.186 and to =- 2.72), found from the observed lengths of 385 individuals, could not be considered as the growth parameters of the species, since old individuals (> 4 yrs) were not present in the samples. Fork length - Weight relationship was found to be : logW = 0.000025 + 2.926log Fl (N = 694, r = 0.92)

All fished individuals were found immature. Since blackspot seabream is a protandrous hermaphrodite species, it could be assumed that the sampled individuals will mainly function as males. Comparing the results of the present work with those found in the literature, we could suggest that all the above estimations could be attributed to the young blackspot seabreams.

REFERENCES

COUPE, R., 1954. Cinquième note sur les Sparides de la côte marocaine, *Pagellus centrodontus* (Val. 1836). Cons. int. Expl. Mer, 11 pp.

FISHER W, M.L. BAUCHOT & M. SCHNEIDER, 1987. Fiches FAO d'identification des espèces pour les besoins de la pêche. Rome, FAO, vol. 2 : 1368 p.

KRUG H.M, 1989. The Azorean blackspot seabream, *Pagellus bogaraveo*, (Brunnich, 1768) (Teleostei : Sparidae) : age and growth. *Cybium*, 13(4) : 347-355.

RAMOS, F. & O. CENDRERO, 1967. Notes on the age and growth of *Pagellus cantabricus* (Asso)of Northern Spain. ICES C.M. 1967/G : 3, 8pp.

SANCHEZ, F., 1983. Biology and fishery of the red-sea-bream (*Pagellus bogaraveo* B.) in VI, VII and VIII subareas of ICES. ICES C.M. 1983/G : 38, 15 pp.

Length classes	0	1	2	3	N
70 - 80	1	0	0	0	1
80 - 90	7	0	0	0	7
90 - 100	55	0	0	0	55
100 - 110	64	10	0	0	74
110 - 120	13	52	0	0	65
120 - 130	0	71	0	0	71
130 - 140	0	53	1	0	54
140 - 150	0	27	23	0	50
150 - 160	0	1	5	0	6
160 - 170	0	0	1	0	1
170 - 180	0	0	0	1	1
N	140	214	30	1	385
Mean FL	100.2	126	146	175	

Table 1. Length-age key of P.bogaraveo in the North Aegean Sea

Age group	N	Mean obs. FL	Age 1	Age 2	Age 3
1	214	126	111.7		
2	30	146	114.1		142.7
3	1	175	118.9	152.8	175
Mean FL			112.0	143.1	175
Annual increament			112.0	31.1	31.9

Table 2. Mean backcalculated lengths of P.bogaraveo in the North Agean Sea

V

NORTHWESTERN MEDITERRANEAN ANCHOVY SPAWNING GROUNDS OFF THE CATALAN SEA, GULF OF LIONS AND LIGURIAN SEA DURING 1992 AND 1993

I. PALOMERA[1], A. GARCÌA[2] and O. GIOVANARDI[3]

[1] Instituto de Ciencias del Mar, Paseo Joan de Borbó s/n, 08039 Barcelona, Spain.
[2] IEO - Centro Oceanográfico de Málaga, P.O. Box 285, Fuengirola, Málaga, Spain.
[3] Istituto Centrale Per La Ricerca Scientifica e Tecnologica applicata al Mare, Roma, Italy

Under the framework of UE financed FAR project on the NW Mediterranean anchovy stock (*Engraulis encrasicolus*) off the Catalán Sea, Gulf of Lions and Ligurian Sea, two fish egg and larval surveys were carried during the peak spawning period (June-July) with the main objective delimitating the spatial distribution of the spawning areas in 1992 in order estimate Daily Egg Production spawning biomass in 1993. The present paper describes the results obtained from the surveys "MAD-0792" and "MPH-MED 93" carried out on board the R/V Garcia del Cid.

MAD-0792. A total of 195 Bongo-40 plankton oblique hauls (200µ mesh) were carried out in stations 10 nautical miles apart within near to perpendicular to the coastline transects, distanced 10 or 12 miles apart, depending on the anchovy spawning intensities expected in different surveyed sectors. In order to assure the maximum limit of anchovy egg vertical distribution (PALOMERA, 1991), tows were carried out to the desired depth of 100 mt depth, whenever possible. Vertical CTD profiles (Seabird Model) were also done at each station providing information on temperature, salinity and relative fluorescence distribution complemented with Doppler profiling of currents (GARCÌA, 1994). The main anchovy spawning grounds are located along a mid cross-section of the Gulf of Lions, whose edges coincide with the shelf break, which practically form a continuation with the more litoral spawning areas off Cape of Creus and the northern Catalonian coasts. At the southernmost sector, the traditional anchovy spawning ground (PALOMERA, 1992) opposite the Ebro river delta outflow is clearly defined, with southwestern extensions. The Liguro-Provençal basin has anchovy spawning grounds located mainly along the Tuscan shelf, limited seaward by the shelf margin; but in comparison to the previously described spawning grounds, the scale of abundances decrease six fold, approximately. Anchovy larvae offer a more spread out distribution due to their longer presence in the planktonic phase. Highest abundances occur in the mid section of the Gulf of Lions, and subsequently following a similar distributional pattern to the egg distribution.The inner litoral sector of the Gulf of Lions register practically insignificant or null presence of larvae. In general, higher larval abundances are recorded in more offshore stations (normally in the second or third station of the transect), rather than the strictly litoral ones. In comparison, anchovy larval abundances decrease greatly in the Ligurian basin, where these have not practically exceeded values over 10 larvae/m^2. These abundances are mostly located in the last transects, near the island of Elba, across Corsica and the Italian coasts, coinciding with the widening of the continental margins. The most productive spawning ground is located in the region comprehended between the northern Catalonian coasts and the Gulf of Lions, where the main bulk of the target species is located, in agreement with the echo-acoustic evaluations carried out in recent years (ABAD *et al.*, 1991). Several common features can be pointed out in relation with anchovy spawning grounds distribution:1) they are associated to river runoffs (e.g., Rhône, Ebro); 2) are influenced by the strong Liguro-Provençal-Catalán current, producing associated cyclonic or anticyclonic eddies that can either disperse or retain larvae in nursery grounds favourable to growth or inversely; 3) hydrological phenomena associated to bottom topography (e.g., submarine canyons).

MPH-MED-0793. During July 1-30, 1993 another anchovy egg survey was carried out aboard the R/V Garcia del Cid with the main objective of estimating spawning biomass through the Daily Egg Production Method. This evaluation technique implies an intensive plankton vertical tow sampling. The basic scheme of egg sampling stations was based on a 5 by 5 nautical mile track (stations and transects), with transects near perpendicular to the coastline, modified in some of the covered regions to 2.5 miles between stations and 10 miles between transects. A total of 602 CalVET net (150µ mesh) vertical tows of 100 m depth were done, representing a coverage of 59,981 km^2 of sea surface. Catalán Sea accounted for 292 plankton hauls, whereas the Gulf of Lions and Ligurian Sea accounted for 138 and 172, respectively. Temperature-salinity with depth from CTD (Seabird 25) profiles were obtained in 278 of the stations sampled (GARCÌA., 1994; Annex V). No spawning activity was observed in the southernmost area of the sampled area from Cape San Antonio to Castellón (Gulf of Valencia). Thereon northward, spawning was detected continously until the Gulf of Lions. The spawning ground associated to the Ebro river delta showed high egg concentrations in the inmediate zone of influence of it's outflow spreading high concentrations seaward, but mainly concentrated along the shelf break where the continental shelf is widest. The influence of the Ebro river discharge on salinity is observed up to 25 miles offshore. Along the coast of the northern sector of the Catalan Sea, the continental shelf is much narrower, thereby limiting spawning to the litoral zone, until the region of the Gulf of Lions. In this area, practically no spawning occurs in its inner coastal section, and once more higher egg densities occur along the margin of the shelf. Two main spawning areas are observed in this region, a western one that forms continuity with the northernmost Catalan sector, and an eastern spawning ground influenced by the Rhône river runoff. In comparison to the southern region, surface temperatures are significantly lower (~19°-20°C) in the Gulf of Lions sector with a gradual increasing trend southward (~20°-22°C).

Although rather spatially restricted, the freshwater river discharge from the Rhône river was observed in the eastern coast of the Gulf of Lions (minimum salinity values 32.750/00). Relative fluorescence intensities increase considerably in the stations close to the river mouth, attaining maximum levels registered during the survey. Coastal upwelling in the interior part of the Gulf was clearly observed which is also reflected on the maximum levels of relative fluorescence intensities. Finally, the anchovy egg distribution off the Ligurian and N Tyrrhenian Sea was concentrated along the continental shelf of the Tuscan region. High egg densities were observed opposite the two river outflows (Arno and Magra) and the northern part of the island of Elba. In this latter zone, rather low sub-superficial temperatures and high salinities were observed indicating an upwelling process which does not reach surface layers. South of this island, isolated and dispersed anchovy egg concentrations were observed.

In conclusion, anchovy spawning grounds distribution is related to the complex hydrology which represents the linking factor of the studied regions, in such a way that the resource has an inter-relationship which should be considered for its assesment.

REFERENCES

ABAD, R., MIQUEL, J. and M. MILLÁN, 1991. *Inf. Téc. Inst. Esp. Oceanogr.*, 131.
PALOMERA, I., 1992. *Marine Ecology Prog. Ser.*, V. 79: 215-233.
GARCÌA, A. (Ed), 1994.Final Report Study Contract FAR Project MA 3.730, DG XIV, UE.

A STUDY OF THE POPULATION DYNAMICS OF THE NORTHWESTERN MEDITERRANEAN ANCHOVY (*ENGRAULIS ENCRASICOLUS*) USING LCA (LENGTH COHORT ANALYSIS)

J.P. PERTIERRA and J. LLEONART

Institut de Ciències del Mar. Plaça del Mar. 08039 Barcelona, España

The use of population dynamics in the evaluation of small pelagics is a controversial topic. The small pelagics have a short life, most of the biomass is presumed to belong to a single year class making them highly dependent of uncertain recruitments, and a highly variable natural mortalities. Hence small pelagics gather the wrong features for the proper operation of the population dynamics methodology, while the acoustic techniques and the egg production method have demonstrate to be efficient estimators of actual biomass. Nevertheless, population dynamics can contribute with a sinchronic view to the more precise, but punctual, direct estimations mentioned above. In this paper a Length Cohort Analysis (LCA) of anchovy is presented. LCA has severe limitations, being the steady state the most restrictive, involving constant recruitment and constant mortalities. For this reason this method has received some criticism (HILBORN and WALTERS, 1992). Nevertheless LCA has at least two useful features: first it gives a wide view of the population status, and second, it can take the data arranged into many classes, hence the scale of study is much more precise than those based on anual classes. This last feature is significant in short lived organisms.

In the framework of a FAR project (GARCIA, 1994) 347 samples of anchovy length frequencies of the commercial landings were taken from Castelló (northern part of spanish coast of the Mediterranean) to Savona (septentrional Tirrhenian), incluiding France. In this paper the preliminary results of the analysis of these data are presented.

Data were grouped according to annual seasons starting on July 1st, as the birthday of the year class. Only the season July-92 to June-93 was complete. The samples were grouped in several ways, ranging various levels of agregation (i.e. harbour, country, gulf of Lion, etc.). Samples taken from Catalonian landings from 1987 to 1993 were also included. The length frequencies were smoothed in order to avoid sampling artefacts.

The resulting length frequencies were analyzed by means of the LCA using VIT software (LLEONART and SALAT, 1992).

The biological parameters employed were, for the von Bertalanffy growth equation: L (infinity) = 20.6 cm, K = 0.38, t0 = -0.937 year. Length-weight relationship: a = 0.0022 gr/vol, b = 3.41 (PERTIERRA, 1987), and Natural mortality (PERTIERRA, 1992): M = 0.81. As a general remark on the data, it must be pointed out that the lower standard length limit was 5.5 cm and the upper one was 19 cm.

In table 1, the main general results are presented. Some particularly significant parameters have been choosed in order to synthetize the great ammount of information from each analysis.

Some general conclusions can be stated. The stocks are kept at levels slightly lower than 50% of the virgin biomass. The turnover rates are, in all cases, higher than 100%. The recruitment represents around 50% of biomass when it reaches its maximum biomass. The values of biomass are absolute and refer to different surfaces, so they are hardly comparable between areas. The great differences between the global fishing mortalities are the most surprising results; sensitivity analysis showed, as it was expected, that these values are not affected (at a significant level) by the terminal F. Taking into account the cautions necessary in the interpretation of such analyses, it appears to be an increase in the biomass of catalan stock in the most recent years.

Yield per Recruit Analysis carried out on the fishing mortality vectors reveal an average subexploitation pattern for most (all except Barcelona) of the studied areas with maximun sustainable yields above the current fishing effort.

Table 1. Results of LCAs carried out on different sets of anchovy data.

F : global fishing mortality weighted by numbers of individuals. **B** : Mean anual biomass in tonnes. **%BV** : B expressed ad percentage of estimated mean anual virgin biomass. **%T** : Turnover (production/biomass) expressed as percentage. **%R** : Percentage of the mean annual biomass represented by one year recruitment at the critical (maximum biomass) point.

1992-1993	**F**	**B**	**%BV**	**%T**	**%R**
Castelló	0.334	4748	48	137	65
Barcelona	0.533	2698	26	165	55
Port de la Selva	0.132	2166	60	116	44
Sète	0.200	8464	56	123	51
Savona	0.307	2076	49	131	59
Sestri Levante	0.412	375	42	142	64
Catalonia	**F**	**B**	**%BV**	**%T**	**%R**
1987-1988	0.353	15638	33	154	59
1988-1989	0.344	23321	39	141	53
1989-1990	0.368	20402	32	155	54
1990-1991	0.338	16529	38	144	53
1991-1992	0.188	19091	47	130	49
1992-1993	0.189	28697	52	121	43
1987-93 (6 seasons)	0.254	21264	41	137	49
Gulf of Lions 92-93	0.145	10548	56	121	47

REFERENCES

GARCIA, A. (Coord.).- 1994. Northwestern Mediterranean Anchovy: Distribution, Biology, Fisheries and Biomass estimation by different methods. Final Report. Contract FAR-CEE MA 3730. HILBORN, R. & C.J. WALTERS.- 1992. Quantitative Fisheries Stock Assessment. Choice, Dynamics & Uncertainty. Chapman & Hall. New York, London. 570 pp.
LLEONART J. & J. SALAT.- 1992. VIT. Programa de análisis de pesquerías. *Inf. Técn. Sci. Mar.*, 168-169: 116 pp.
PERTIERRA, J.P.- 1987. Crecimiento del boquerón (*Engraulis encrasicolus*) de la costa catalana. *Inv. Pesq.*, 51:263-275.
PERTIERRA, J.P.- 1992. Biología pesquera de la anchoa *Engraulis encrasicolus* del Mar Catalan (NW Mediterraneo). Tesis Doctoral. Universitat Politècnica de Catalunya. 281 pp.

V

AGE AND GROWTH OF COMBER, *SERRANUS CABRILLA* (L., 1758), IN THE THRACIAN SEA AND THE THERMAEKOS GULF (NORTHERN GREECE)

Chrissi-Yianna POLITOU and Costas PAPACONSTANTINOU

National Centre for Marine Research, Aghios Kosmas, 16604 Hellinikon, Greece

Comber *Serranus cabrilla* is a commercial fish with a disribution ranging from the North Atlantic Sea, up to the North Sea, to the Mediterranean Sea. It is a permanent hermaphrodite species. Aspects of its biology have been reported for the waters of Tunisia (BOUAIN, 1981, 1983), whereas no other references concerning the biology of the species exist. This paper deals with the age and growth of comber in greek waters, since the knowledge of growth parameters is of high importance in biology and fisheries studies.

Sampling was conducted seasonally between June 1992 and December 1993 using a commercial trawler towing a net with a cod-end of 16 mm mesh size (knot to knot). The fork length (FL) of the specimens collected ranged between 102 and 244 mm. The age was studied by otolith reading under reflected light. After counting the number of rings, the distance was measured from the focus to the distal edge of each annulus and to the otolith edge. A marginal increment analysis showed the formation of an annual ring during summer. The back-calculated lengths were fitted to the von Bertalanffy model using the nonlinear least square method.

Otolith reading showed that 8 age groups were present in our samples: 1 to 8. The 0 group was not captured by the gear. The relationship between body length (FL) and otolith radius (R) was expressed by a linear regression, which fitted the data well:

$FL = -18.05 + 4.40R$, $r^2 = 0.85$, N=469

The formula of FRASER (1916) and LEE (1920) was used to calculate the fish length at the time of the formation of each ring and the results obtained are shown in table 1.

Age	N	FL (mm) observed	Back-calculated FL (mm) 1	2	3	4	5	6	7	8
1	33	112.7 (8.62)	81.0 (10.16)							
2	183	136.6 (12.83)	78.1 (8.65)	120.3 (10.40)						
3	141	158.9 (12.12)	79.1 (9.51)	122.1 (10.81)	147.8 (11.23)					
4	53	183.1 (9.33)	80.9 (9.28)	123.4 (9.81)	150.9 (10.27)	171.2 (9.77)				
5	25	196.7 (9.02)	83.6 (11.67)	127.6 (11.66)	155.7 (10.67)	174.4 (11.00)	188.2 (10.16)			
6	25	212.6 (13.61)	85.1 (8.55)	130.0 (8.43)	157.5 (10.29)	177.5 (10.67)	193.4 (12.35)	206.1 (13.16)		
7	7	217.6 (16.42)	78.7 (7.60)	123.5 (10.69)	149.3 (11.14)	169.6 (12.36)	187.5 (13.38)	201.4 (13.84)	212.3 (15.62)	
8	2	217.0 (8.00)	73.1 (6.04)	119.9 (12.28)	149.8 (17.79)	167.6 (15.39)	181.3 (12.81)	195.9 (9.21)	206.5 (9.66)	215.0 (10.03)
Mean FL/age			79.6	122.3	150.3	173.2	190.1	204.5	211.0	215.0
CL 95%			0.87	1.03	1.44	2.06	3.13	4.60	11.28	30.49
N			469	436	253	112	59	34	9	2
Mean annual increment			79.6	42.7	28.0	22.9	17.0	14.4	6.5	4.0

Table 1. Mean observed and back-calculated lengths of *Serranus cabrilla* in northern Greece. In parentheses the standard deviation; N = number of fish examined CL 95% = 95% confidence limits.

The back-calculated lengths agreed reasonably with lengths at capture. Differences, such as larger mean observed than back-calculated length, are attributed to growth following mark formation or to recruitment of the larger specimens only for the first age group. Apparently back-calculated lengths did not display Lee's phenomenon.

The von Bertalanffy model applied for comber gave the following growth parameters: $L_\infty = 238.1$ mm, K=0.3, to=-0.367

The mean square error between back-calculated lengths and those estimated using the von Bertalanffy model was low (1.04) indicating a good fit of the model to the data.

The maximum length calculated for comber in northern Greece was lower than that obtained for the south-east coast of Tunisia, where older specimens (9 years old) were also found.

Finally the length (FL) - weight (W) relationship was computed and expressed by the following regression:

$$W = 0.0000521 * FL^{2.725}, r^2=0.90, N=665$$

REFERENCES

BOUAIN A., 1981. Les serrans (Téléosteens, Serranidés) des côtes sud de la Tunisie - Taille de première maturité, période de reproduction. *Cybium*, 5(4): 65-75.

BOUAIN A., 1983. Croissance linéaire des serrans des côtes sud-est de la Tunisie. Rapp. P.-V. Reun. CIESM, 28(5): 87-91.

FRASER C. McL., 1916. Growth of the spring salmon. *Trans. Pacif. Fish. Soc. Seattle*, for 1915: 29-39.

LEE R. M., 1920. A review of the methods of age and growth determination by means of scales. *Fishery Invest.*, Lond., Ser.II. 4(2): 32 pp.

STOCK ASSESSMENT OF WHITING (*MERLANGIUS MERLANGUS EUXINUS* NORDMANN) ALONG BULGARIAN BLACK SEA COAST DURING 1976-1993

Kamen PRODANOV[1] and Georgy DASKALOV[2]

[1] Department of Marine Biology,Institute of Oceanology, Varna, Bulgaria
[2] Department of Ichthyology, Institute of Fisheries,Varna, Bulgaria

The catches of whiting are obtained with trapnets and also – it appears as bycatch – in the sprat fishery, with the bathypelagic trawl. All this embarrasses the correct determination of actual catches on account of which the whiting has always been considered as a poorly exploited fish (DOMASHENKO and SEROBABA, 1990). The largest catches have been realized by Turkey : the mean catch during 1981-1991 is 20.46 thousand tons. Length composition of these catches varied from 8-10 to 30-34 cm , while the Bulgarian catches ranged whitin 5-25 cm.

Whiting biomass during 1976-1993 was calculated by VPA (MESNIL, 1989) and Jones'length converted cohort analysis (LCOHORT) (SPARRE, 1987). The fishing efforts, respectively the values of Fst for sprat are according to IVANOV's (1989) and DASKALOV's (1993) data. As it was mentioned, the whiting catches are realized mainly as a bycatch in the sprat fishery. That's why we used the sprat values for Fst although the whiting is a demersal fish, while the sprat is a mudfish. Besides, the eldest age groups of whiting (5 and 6 years old) keep away from the shore in contrast to sprat whose fishery is going on in the coastal zone (20-40m depth). Having in mind all these differences, we consider that the assessment made have to examine as an attempt for determining the margin stock of whiting along Bulgarian Black sea coast.

In table 1. the results from VPA and LCOHORT are represented. It appears that assessments obtained by the above mentioned methods differ from one another mainly during 1990-1991. Accordig to VPA and LCOHORT analyses the initial and mean biomasses of whiting had varied from 27 273.6 tons (1976) to 10 893.4 tons (1988) and from 16 072.3 tons (1978-1979) to 2 554.1 tons (1990-1991), respectively. Having in mind the abundance of offspring, we consider that the assessments made by LCOHORT analysis reflect more correctly the actual state of whiting's stocks during the last 4 years. The sharp decrease of the whiting's biomass is due to the low abundant generations from 1987 to 1989. The increase of whiting's biomass after 1991 is conditioned by the streigth abundant generation of 1990 : more than 50 and 7 times in comparison with generations of 1987 and 1988, respectively.

ARKHIPOV and ROVNINA's (1990) data confirm the considerable decrease of the abundance of the generations after 1987, which comes to show that the natural reproduction of whiting was seriously disturbed between 1987-1989. The reasons for that are complex and are related to the significant alterations of the environment : the "blooms" of the phytoplancton were more frequent and more extensive. The food supply of the larvae and young fish was also subjected to rapid variations connected with the overall changes of the environment as well as with the mass development of the new ctenophore *Mnemia mccradyi*, which appears to be a vigorous competitor in relation to the small-size crustaceans from Copepoda and also presents itself as a predator on eggs and maybe fish larvae (ZAIKA, SERGEEVA, 1991).

Table 1. Initial (calculated by VPA) and mean biomasses (calculated by LCOHORT) of whiting along Bulgarian Black Sea coast (1976 - 1993)

Years	*B_{1-4+}	*F_{1-4+}	**B_{10-18+}	**F_{10-18+}
1976	27273.6	0.0628	12652.2	0.0997
1977	25281.6	0.0797	12652.2	0.0997
1978	25234.4	0.1219	16072.3	0.1161
1979	25104.2	0.1157	16072.3	0.1161
1980	21610.6	0.2451	12441.1	0.1946
1981	17861.1	0.2284	12441.1	0.1946
1982	15693.3	0.2703	10415.6	0.1945
1983	13469.7	0.1545	10415.6	0.1945
1984	14687.6	0.1497	10568.9	0.1557
1985	14632.4	0.1324	10568.9	0.1557
1986	13967.5	0.1137	6886.1	0.1511
1987	12760.9	0.1314	6886.1	0.1511
1988	10893.4	0.1230	6343.2	0.1245
1989	12100.6	0.0765	6343.2	0.1245
1990	14543.4	0.0253	2554.1	0.1113
1991	15399.6	0.0206	2554.1	0.1113
1992	15123.8	0.0427	6397.7	0.0690
1993	12813.5	0.0657	6397.7	0.0690

B1-4+ - amount of the initial biomasses of the age groups from 1 to 4+ ;*F1-4+-the mean value of fishing mortality coefficient from 1 to 4+;B10-18+-amount of the mean biomasses of length classes from 10 to 18+ cm; **F10-18+-the mean value of fishing mortality for length classes from 10 to 18 cm;*

ACKNOWLEDGEMENTS: the present study was partly supported by the Research Support Scheme of the Central European University, no:182\1041\91-92.

REFERENCES

ARKHIPOV, A.G and O.A.ROVNINA,1990. Liv. resources in Black sea. Moskow. 64-80

DASKALOV, G.1993. Rapport de DEA. Univ. Aix-Marseille II. OSU(COM)

DOMASHENKO, G.P and I.I.SEROBABA.1990. Liv. res. in Black sea. Moskow. 142-145

IVANOV,L.S,1989. *Hydrobiology*, Sofia, v.34, 68-89

MESNIL B,1987. IFREMER/RH. Nantes CEDEX 01. pp. 73

SPARRE P,1987. FAO Fish Tech. Rapp.101, Suppl.2

ZAIKA V.E and SERGEEVA N.G,1991. *Gidrobiol. jurnal*, 27. 2 : 15-19

V

POPULATION DYNAMICS OF *MERLUCCIUS MERLUCCIUS* EXPLOITED BY TWO DIFFERENT TRAWL-NETS IN THE NORTHERN TYRRHENIAN SEA

Bruno REALE[1], Mario SBRANA[2], Stefano DE RANIERI[1]

[1] Centro Interuniversitario di Biologia Marina, Livorno, Italy
[2] Dipartimento di Scienze dellí Ambiente e del Territorio, Università di Pisa, Italy

An intense activity of trawl fishery is taking place at present in the Northern Thyrrhenian Sea. A survey has been undertaken to evaluate the conditions of exploitation of hake, *Merluccius merluccius*, using Porto Santo Stefano as sample port. In 1992 and 1993, the hake landings amounted to 460 and 344 tons respectively, that is 34% and 28% of all commercial species landings.

The local fishery uses two kinds of trawl-nets: the Italian traditional net (19 boats with 42% of hake catches in the 1992 and 13 boats with 38% catches in the 1993) and the so called "french" net (1992, 20 boats with 58% catches and 1993, 18 boats with 62% catches). The boats equipped with french net (vertical opening up to 10 m) have an engine power (538+/-148 Hp) stronger than those of the boats using the traditional net (380+/-106 Hp, about 1 m vertical opening) (SARTOR & DE RANIERI, 1994). In both types of gears, the streched mesh size is 36 mm long.

Length frequency distributions have been calculated by four different commercial categories of the landing carried to the local fish market (VIVA & DE RANIERI, 1994), measuring the total lengths of 5474 (1992) and 6608 (1993) specimens and expanding it appropriately to the total amount of the monthly landing of the species. The growth parameters (Loo = 92.98 cm, K = 0.119) have been calculated by analysing the length frequency distributions of the 1992 landing, by the ELEFAN program (GAYANILO *et al.*, 1988), t0 = -0.05 by indirect method, M = 0.226 by empiric Pauly's method, Fterm = 0.1 experimentally and the parameters of the weight-length relationship from the measured samples (1992, a = 0.00376 and b = 3.177; 1993, a = 0.00390 and b = 3.159). With the by length arranged data (2 cm step), the virtual population has been calculated by the Length Cohort Analysis (POPE, 1972) and the yield per recruit has been analysed using the VIT program (LLEONART & SALAT, 1992).

No particular differences appear between the size classes of the two years (Fig. 1). The length frequency distributions of the landing of both gears are principally constituded by size classes smaller than the first sexual maturity ones (27 cm males, 46.5 cm females). Specimens from 7 to 108 cm of total length with an average size of 16.9 and 15.3 cm for the french net, 15.1 and 14.3 cm for the traditional net have been sampled respectively in 1992 and 1993.

Even going over the total fishing mortality vectors and the two different nets one, substantial differences between the two years cannot be observed (Fig. 2). We can notice higher values for the traditional net about the length classes between 12 and 23 cm; 13 and 41 for the french net. The turnover is high (in the 1992 116%, in the 1993 132%). Comparing the yields per recruit (Fig. 3) we can observe that the values of the different effort levels referring to the french net are always higher than the traditional net ones. In 1993, such values are slightly lower than the previous years. The average lengths of the catches, the fishing mortality vectors and the maximum sustainable yields show a different impact of the two gears on the population owing to the technical caracteristics of the nets (vertical opening, selectivity) and to the work depth (maximum 150 m for the french net). Through the obtained results, we can assume an hake overexploitation rate for both the gears, which needs a drastic reduction of the fishing effort. That is not economically realistic at present, therefore it would be advisable studying a change of the fishing strategy.

The above described situation refers only to the population exploited by trawl and does not take into consideration the effect of the other gears. At the moment, a survey is being carried out to evaluate the impact of the gill-nets on the hake stock.

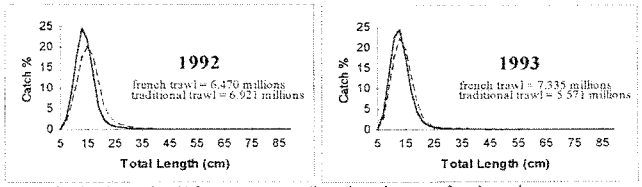


Fig. 1 - Catches in number % for gear ____ traditional trawl _ _ _ _ french trawl

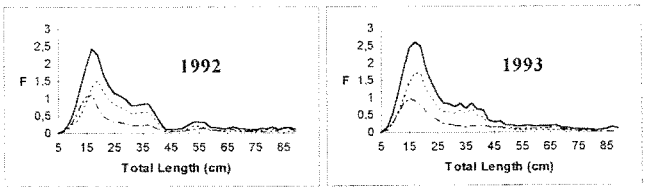


Fig. 2 - Fishery mortalities ____ total _ _ _ _ traditional trawl _ _ _ _ french trawl

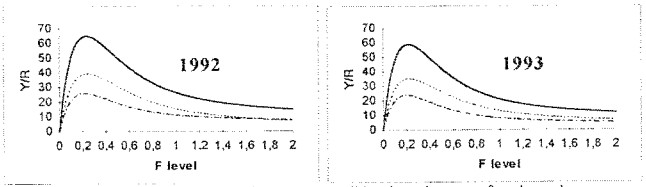


Fig. 3 - Yield per recruit (g) ____ total _ _ _ _ traditional trawl _ _ _ _ french trawl

REFERENCES

GAYANILO F.C., *et al.* 1988. ICLARM, Manila Philippines. Software 2 : 65 pp.
LLEONART J. & SALAT J. 1992. *Inf. Téc. Sci. Mar.*, 168- 169 : 116 pp.
POPE J. G. 1972. Int. Commn. *Northwest Atl. Fish. Res. Bull.*, 9 : 65-74.
SARTOR P. & DE RANIERI S. 1994. *Biol. Mar. Medit.*, 1 (1) : 311-312.
VIVA C. & DE RANIERI S. - 1994. *Biol. Mar. Medit.*, 1 (1) : 321-322.

ANALYSE COMPARATIVE DES CAPTURES DE DIFFÉRENTS ENGINS DE PÊCHE DE FOND DANS LA ZONE LITTORALE (< 80 M PROFONDEUR)

Laura RECASENS[1] et Paolo SARTOR[2]

[1] Institut de Ciències del Mar de Barcelona, Plaça del Mar s/n, 08039 Barcelone, Espagne
[2] Centro Interuniversitario di Biologia Marina, Livorno, Italie

L'objectif principal de cette note est la comparaison des captures obtenues avec différents engins de pêche qui travaillent sur les fonds de la zone littorale, à moins de 80 m profondeur. On a considéré quatre engins: le grand chalut, le petit chalut et le "rastell" sont utilisés à partir des ports de la cité catalane de Vilanova i la Geltrú (Vil) et de Sant Carles de la Ràpita (Rap) et le "rapido" est utilisé par un nombre réduit de bateaux des flottilles de Porto Santo Stefano (PSS) et de Castiglione della Pescaia (CdP), sur la cite toscane. Les caractéristiques techniques moyennes des bateaux qui pêchent avec ces quatre engins sont (SANCHEZ et PDPEM, 1991; SANCHEZ et PDPEM, 1993) :

	Tonnage brut (t)				Puissance (HP)			
	Vil	Rap	PS	CdP	Vil	Rap	PSS	CdP
Grand chalut (>150 HP)	48.3	62.5			317	440		
Petit chalut (<150 HP)	7.4	18.0			36	79		
"Rapido"			42.2	21.8			515	234
"Rastell"	3.9	3.4			29	27		

Les deux premiers engins sont des chaluts de fond à panneaux : leurs caractéristiques structurales sont semblables, la différence étant que les petits chalutiers pêchent avec des engins de dimensions plus petites. Les engins travaillent avec une ouverture verticale d'environ 2 mètres maximum et une longueur de maille de 26 à 42 mm. Nous avons considéré seulement les pêches réalisées entre 9 et 80 m où travaille la flottille des petits chalutiers et une partie des grands. Les "rastells" sont des engins qui présentent une bouche de structure rigide et ovale d'environ 2 mètres de diamètre maximum. Ces engins ne portent pas de panneaux et les dimensions totales des filets sont de 8 mètres de longueur. Ils portent toujours des lignes de chaînes (entre 13 et 16). Les profondeurs de pêche habituelles sont entre 3 et 38 m. La structure du "rapido" est très semblable à celle du "rastell" : le "rapido" a une bouche rectangulaire de 3 à 3.5 m de largeur et il est un peu plus long. Cet engin, qui est utilisé par les flottilles italiennes seulement entre mai et août, pêche d'habitude entre 25 et 60 m, une profondeur moyenne un peu plus élevée que celle du "rastell". Tous les bateaux qui pêchent avec le "rastell" ou le "rapido" utilisent deux filets, en parallèle ou l'un après l'autre.

Le tableau suivant montre l'importance relative des espèces et des groupes d'espèces qui sont les cibles principales de ces engins. Les pourcentages ont été calculés comme une moyenne annuelle à partir des captures mensuelles entre les ports où ils travaillent, dans le cas des chaluts de l'année 1991, pour le "rastell" l'année 1993 et pour le "rapido" des années 1992-93.

	GRAND CH; %total	PETIT CH %total	RAPIDO %total	RASTELL %total
Bolinus brandaris	1.28	4.88	21.78	42.60
Autres gastéropodes	0.52	0.01	1.90	4.80
Chamelea gallina	0.00	0.00	0.00	20.06
Autres bivalves	0.00	0.53	2.00	13.82
Octopus vulgaris	6.51	5.72	15.59	2.76
Eledone cirrhosa	0.64	2.54	7.70	0.00
Autres céphalopodes	6.95	5.53	3.15	1.81
Squilla mantis	4.70	16.43	5.92	2.07
Liocarcinus depurator	1.51	6.66	0.50	3.73
Autres crustacés	0.48	4.72	0.59	4.72
Merluccius merluccius	0.77	13.41	2.63	0.02
Mullus spp	7.61	6.23	0.69	0.05
Sardina pilchardus	6.69	0.29	0.00	0.02
Citharus linguatula	1.66	1.70	5.08	0.15
Soleidae	0.44	1.53	5.92	1.30
Autres poissons plats	1.24	6.43	1.44	0.90
Uranoscopus, Trachinus	1.60	1.32	11.22	0.15
Gobiidae	1.49	3.27	3.76	0.08
Sparidae	5.34	3.15	0.00	0.03
Triglidae	0.72	0.97	3.51	0.48
Autres poissons	25.86	14.65	6.63	0.44

Les grands chalutiers capturent des poissons (merlu, rouget, sardine, Sparidae) et aussi des céphalopodes (*Octopus vulgaris*). Le petit chalut capture une moindre quantité de poisson; la différence est qu'il capture aussi des crustacés (*Squilla mantis, Liocarcinus depurator*). Les capiures du "rapido" sont constituées par des gastéropodes, des poissons plats, d'autres poissons benthiques et des poulpes (*Eledone cirrhosa, O. vulgaris*), les espèces démersales étant pratiquement absentes. Le "rastell" pêche des gastéropodes et bivalves (*Bolinus brandaris, Chamelea gallina*), les captures d'autres espèces étant occasionnelles. Les différences entre les captures des quatre engins sont dues aux caractéristiques structurales des engins, mais peuvent être dues aussi aux différentes communautés exploitées, comme le cas du "Rapido" et du "Rastell", deux engins aux caractéristiques assez semblables mais qui travaillent à des profondeurs différentes.

REMERCIEMENTS

Le travail a été financée par la Generalitat Catalunya, Direcció General Pesca et Ministero Marina Mercantile. Notre gratitude aux équipes de travail PDPEM de Barcelone, DSAT de Pisa et CIBM de Livorno par la collaboration dans l'obtention des données.

RÉFÉRENCES

SANCHEZ, P. et PDPEM, 1991. Estudi de l'impacte de la pesca dels arrastrers petits en els stocks d'espècies comercials de la costa catalana. 221 pp. (mimeo).
SANCHEZ, P. et PDPEM, 1993. Anàlisis de l'impacte de la pesca amb rastell sobre les poblacions d'organismes marins. 132 pp. (mimeo)

V

LITTORAL FISH COMMUNITY OF CABRERA NATIONAL PARK (BALEARIC ISLANDS) : QUALITATIVE DATA

O. RENONES[1], J. MORANTA[1], J. COLL[2], B. MORALES-NIN[2] and P. OLIVER[3]

[1] Laboratorio de Biologia Marina, Universitat de les Illes Balears,
[2] Institut d'Estudis Avançats de les Illes Balears, Campus Universitario,
[3] Centro Oceanográfico de Baleares, Apdo. 291.
07080 Palma de Mallorca, Spain

Studies of marine reserves in the Mediterranean have been carried out by comparing protected with non-protected areas (BELL, 1983; GARCIA & ZABALA, 1991; FRANCOUR, 1989, 1991). However, comparing the same zone over a period of time would seem to be the best way to evaluate the changes which occur as a result of differing approaches to management in a protected area (ROBERT & POLUNIN, 1992). This study provides information about littoral fish populations of Cabrera National Park. These data will permit future evaluation of the changes produced by the management measures adopted. Visual censuses were used to evaluated the mean and total species richness in transects of 50 m long and 5 m wide. The following sampling stations have been studied : 3 stations of rocky blocks at 5 and 25 m depth and 2 stations over vertical cliffs at 15 m (photophilic algal community), 2 stations at 40 m (sciaphilic algal community) and 1 station over *Posidonia oceanic*a at 15 m depth. During summer 1993, five replicates on consecutive days of each station were made between 10.00 and 14.00 g.m.t. Cluster analysis was applied to qualitative data from samples. The Jaccard index was chosen as measures of the similarity, and UPGMA was used as the aggregation algorithm (SNEATH & SOKAL, 1973). A total of 49 species from 20 families has been recorded. Labridae dominated the community with 10 species and other important families were Sparidae and Serranidae (Table 1). Greatest species richness has been seen at stations on shallow blocks and it is attributed to greater trophic abundance (HARMELIN, 1990). The structural complexity of the environment and the depth gradient, with distinctive associated benthonic communities, were the two discriminant factors shown by the samples.

The samples from blocks at 40 m depth are the first group to appear in the cluster analysis (Fig. 1) and they are characterized by the presence of species only seen in these transects (*A. anthias* and *G. vittatus*) and the corresponding absence of those with shallower distribution (*E. guaza, S. scriba, S. salpa, S. ocellatus, S. roissali, T. pavo, G. buchichi, T. delaisi* and *T. melanurus*). Secondly, the samples from the *P. oceanica* beds separate out. The last to separate are the cliffs and blocks of the photophilic algal communities. In this case, structural complexity of habitat is more important than depth or sampling place in the determination of the qualitative composition of the fish communities between 5 and 25 m.

BENTONIC COMUNITIES	Photophilic								Sciaphilic		Posidonia
	blocks						cliffs		blocks		oceanica
Stations	1	2	3	1	2	3	4	5	4	5	6
Depth (m)	5			25			15		40		15
DASYATIDAE						1					
MURAENIDAE				1	1	1	1	1	1	1	
CONGRIDAE									1		
GADIDAE					1					1	
SERRANIDAE	2	3	2	3	2	4	3	2	2	2	1
APOGONIDAE	1	1	1	1	1	1	1	1	1	1	
CARANGIDAE		1									
SCIAENIDAE			1								
MULLIDAE	1	1	1	1	1	1	1	1			
SPARIDAE	5	5	7	5	3	3	2	1	1	2	
CENTRACANTIDAE			1	1	2	2			2	2	2
POMACENTRIDAE	1	1	1	1	1	1	1	1	1	1	1
LABRIDAE	10	10	6	7	9	8	4	4	4	6	6
GOBIIDAE		3		1	1	1		2	4	3	
BLENNIIDAE	1		1				1	2			
TRIPTERYGIIDAE	2	2	2	2	1	1					
SPHYRAENIDAE			1			1				1	
MUGILIDAE	1										
SCORPAENIDAE	1		1	2	3	2	1		1	1	
ATHERINIDAE											1
Mean S	18.8	19.0	17.2	18.0	17.0	17.8	11.4	11.0	11.4	13.0	8.4
(±SE)	0.85	0.94	1.02	0.54	0.89	1.07	0.40	0.70	0.51	0.54	1.35

Table 1. - Number of species by family and mean species richness.

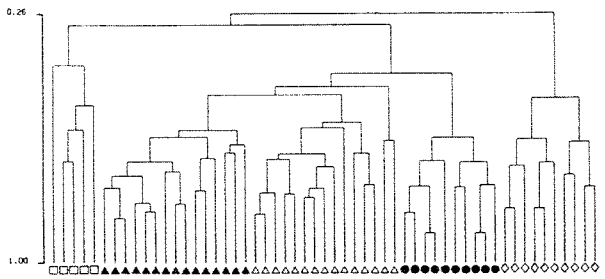


Fig. 1. - Dendogram of similarities between samples (□ : P. oceanica community; ▨ : Sciaphilic algal community blocks at 40 m depth; ▲ : Photophilic algal community blocks at 5 m depth; △ : Photophilic algal community blocks at 25 m depth; ● : Photophilic algal community cliffs at 15 m depth).

REFERENCES

BELL J.D., 1983. *J. appl. Ecol.*, 20 : 357 -369.
FRANCOUR P., 1989. *Trav. sci. Parc nat. reg. Corse*, 21 : 33 -93.
FRANCOUR P., 1991. *Rev. Ecol. (Terre Vie)*., 46 : 65 -81.
GARCIA -RUBIES A. & ZABALA M., 1990. *Sci. Mar.*, 54(4) : 317 -328.
HARMELIN J.G., 1990. *Mésogée.*, 50 : 23 -30.
ROBERT C.M. & POLUNIN N.V.C., 1991. *Rev. Fish Biol.Fish.*, 1 : 65-91.

SOME ASPECTS OF THE REPRODUCTION PATTERN OF HAKE (*MERLUCCIUS MERLUCCIUS*) IN THE BALEARIC ISLANDS

O. RENONES, E. MASSUTI and P. OLIVER

I.E.O. Centro Oceanogràfico de Baleares, Apdo. 291, 07080 Palma de Mallorca, Spain

Hake (*Merluccius merluccius*) is one of the target species of the trawl fishery carried out on the continental shelf and slope off the Balearic Islands (OLIVER, 1993). The aim of the present paper is to provide new information about the reproductive cycle (spawning time and size at first maturity) of this species in the area. Parameters which, used together with fecundity, determine the potential reproduction of the stock and the optimum age for first capture, both very important aspects for the application of the fisheries analysis programmes in the regulation of fishing activity.

The material used in this study comes from monthly biological sampling of the trawl fishery carried out between January 1990 and December 1992 by the Balearic Oceanographic Centre (I.E.O - Centro Oceanogràfico de Baleares). A total of 2831 specimens were sampled, with a length range between 10 and 66 cm : 1382 females, 1210 males and 239 unidentified.

The stages of maturity were determined by macroscopic observation of the gonads using a five-point scale proposed by HOLDEN and RAITT (1975). Monthly changes in the percentage of mature specimens by sexes were calculated by grouping maturity stages 3, 4 and 5. The size at attainment of maturity (length at which 50% of the specimens had become mature) was determined separately for the sexes using the programme LIONOR (J. LLEONART, unpublished). In 1992, the monthly Gonosomatic Index (GSI = gonad weight*100/gutted body weight) was calculated for 365 females and 257 males from March to December.

In both sexes, reproductive activity occurred all the year round (Table 1). The maximum percentage of mature females was obtained in March, May, September and December and, for males, in May, June and September. These results are similar to those obtained with the GSI monthly evolution (Fig. 1), which shows three peaks in both sexes.

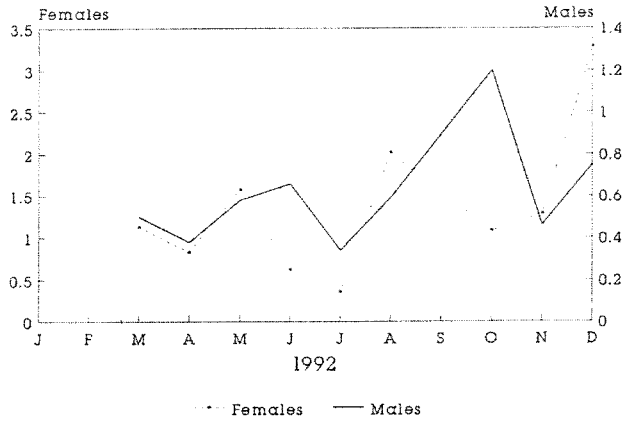
Results indicate a prolonged spawning period for the species, with maximum reproductive activity in the spring, the end of summer and winter, which agrees with the reproductive cycle described by BOUHLAL (1973) in Tunisia. It confirms the existence of a spring spawning peak found by BRUNO *et al.* (1979) in Majorcan waters, which has not been found along the Catalonian coast (RECASENS, 1992).

The size at attainment of maturity was 36 and 27 cm for females and males, respectively, with a maturity range between 23 cm (below which all specimens are immature) and 43 cm (above which all individuals are mature). These values fall within the range indicated for hake in the western Mediterranean (OLIVER and MASSUTI, 1994). Although the size at first maturity obtained for females is slightly higher than that indicated by BRUNO *et al.* (1979) in the same area.

Table 1.- Percentage of maturity by sexes and length. n: number of fish sampled each month.

length (cm)	J	F	M	A	M	J	Jl	A	S	O	N	D
Females												
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	20.0	21.7	31.8	0.0	43.8	0.0	13.0	3.7	15.8	9.1	0.0	46.7
35	61.3	56.3	65.2	20.8	62.5	14.3	23.8	38.5	58.8	44.4	16.0	85.2
40	90.0	60.0	92.3	40.0	50.0	63.6	70.6	85.7	85.7	62.5	40.0	75.0
45	50.0	100.0	0.0	66.7	75.0	60.0	22.2	100.0	75.0	75.0	70.0	50.0
50	60.0	-	0.0	100.0	50.0	50.0	33.3	100.0	100.0	66.7	85.7	16.7
55	100.0	-	0.0	50.0	-	-	-	-	-	50.0	100.0	66.7
60	66.7	100.0	0.0	100.0	-	0.0	66.7	-	-	-	100.0	100.0
n	177	133	96	120	90	126	132	114	116	113	107	95
Global (%)	27.7	25.6	36.5	10.8	34.4	11.1	18.9	16.1	43.1	16.8	24.3	52.9
Males												
20	5.9	7.0	17.0	6.3	11.4	11.1	6.7	3.6	28.6	23.3	2.0	5.3
25	7.7	40.0	28.6	9.5	51.9	51.4	34.3	9.1	40.5	59.4	9.1	70.0
30	33.3	36.4	50.0	37.5	96.2	74.1	75.0	46.7	50.0	50.0	0.0	93.8
35	50.0	20.0	-	25.0	80.0	50.0	33.3	100.0	100.0	50.0	0.0	50.0
40	0.0	0.0	-	-	-	-	100.0	100.0	-	100.0	40.0	-
45	-	-	-	-	-	0.0	-	-	-	-	-	-
n	91	123	122	120	112	100	97	88	84	109	86	79
Global (%)	7.7	22.8	24.6	15.8	42.9	43.0	33.0	19.3	38.1	41.3	4.7	31.7

Fig. 1.- Gonosomatic index of males and females from March to December.



REFERENCES

BOUHLAL M., 1973. *Bull. Inst. Oceanogr. Pêche.* Salammbo. 2 : 579-603.
BRUNO J., OLIVER P., ASTUDILLO A., PASTOR X. & DAROCA E., 1979. *Rapp. Comm. int. Mer Médit.*, 25/26 : 79-86.
HOLDEN M.J. & RAITT D.F.S., 1975. FAO Doc. Téc., 115.
OLIVER P., 1993. *Sci. Mar.*, 57 (2-3) : 219-227.
OLIVER P. & MASSUTI E., 1994. The Fish and Fisheries Series. A Chapman and Hall Book Series (in press).
RECASENS L., 1992. Phd thesis, Univ. Barcelona, 398 pp. (mimeo).

V

BRIEF NOTE ON BIOLOGICAL PARAMETERS OF *TRISOPTERUS MINUTUS CAPELANUS* (RISSO) IN THE NORTHERN TYRRHENIAN SEA

P. RIGHINI, R. SILVESTRI and A. ABELLA

C.R.I.P. Via dell'Ambrogiana, 257127 Livorno, Italia

The data used in this paper have been obtained from trawl-surveys with a design random stratified by depth carried out during the years 1992-93 in the Northern Tyrrhenian Sea. The only fishing gear utilized was the traditional italian low-opening bottom trawl (tartana) with a 40 mm stretched mesh size at the codend.

The "poor cod" (cappellano) is one the most abundant species in the assemblage of soft bottoms of the shelf edge (circalittoral bottoms) (ABELLA & SERENA, in press) with the "horned octopus" (*E. cirrhosa*) and "smallspotted catshark" (*S. canicula*). This commercial gadoid is present between 70 and 280 m of depth. The best catch rates of "poor cod" (max 22 kg/h in Summer) were obtained between 90 and 140 m of depth (with some differences relatively to the seasons).

During the surveys were collected fish total length frequencies with half-centimeter precision by sex. Sex was determinated by macroscopical observations of gonads but the youngest immature specimens were not sexed (T.L.< 10 cm) and were recorded as indeterminated; the young specimens were collected in Spring (the smallest with T.L. = 3.5 cm) and Summer (the smallest with T.L. = 4.5 cm).

Length-frequencies distributions by sex (with a parithetic 50% of the small unsexed individuals assigned to each sex) were used to estimate growth of this species with the programm Compleat ELEFAN (PAULY, 1987). This artifact does not create any problem for the accuracy of the results.

As follows the parameters of the Van Bertalannfy growth equation, obtained for females and males, are compared to the same obtained in Adriatic Sea (GIANNETTI & GRAMITTO, 1988) :

	N.Tyrrhenian Sea			Adriatic Sea		
	Loo	K	t0	Loo	K	t0
Females	28.5	0.60	-	24.72	0.802	-0.029
Males	24.0	0.48	-	23.59	0.464	-0.399

Age (yrs)	Females	Males	Females	Males
1	12.9	9.1	13.9	11.2
2	19.9	14.8	19.9	15.8
3	23.8	18.3	22.5	18.6
4	25.9	20.5	23.7	20.5
5	27.1	21.8	24.3	21.6

Growth rates of females and males show significative differences (Fig. 1); at the same age the females are more larger than males in agreement with GIANNETTI & GRAMITTO (1988). Ripe and spent females were collected in Spring (May); sexual maturity is reached over 13 cm of T.L. in agreement with FROGLIA (1981) and FROGLIA & ZOPPINI (1981).

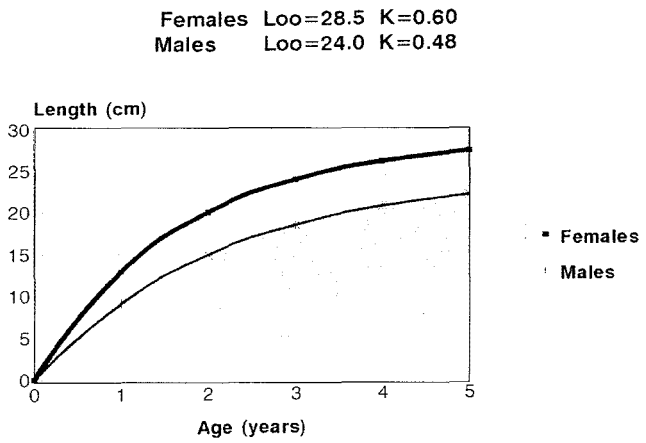


Fig. Growth curves of *T. minutus capelanus* in the N. Tyrrhenian Sea

REFERENCES

FROGLIA C. 1981. Summary of biological parameters on *Trisopterus minutus capelanus* (Risso) in the Adriatic. *FAO Fish. Rep.*, 253: 97-100.

FROGLIA C. & ZOPPINI A.M. 1981. Observations on growth of *Trisopterus minutus capelanus* (Risso) (Pisces, Gadidae) in the Central Adriatic Sea. *Rapp. Comm, int. Mer Medit.*, 27,5.

PAULY D. 1987. A review of the ELEFAN system for analysis of length-frequency data in fish and acquatic invertebrates, p. 7-34. In D. Pauly and G.R.Morgan (eds.) Length-based methods in fisheries research. ICLARM Conf. Proc. 13, 468 p.

GIANNETTI G. & GRAMITTO M.E. 1988. Growth of Poor Cod *Trisopterus minutus capelanus* (Lacepedä) (Pisces, Gadidae) in the Central Adriatic Sea. *Rapp. Comm. int. Mer Medit.*, 31, 2.

ABELLA A. & SERENA F. (in press). Definizione di assemblaggi demersali nell'Alto Tirreno.

MISE EN ÉVIDENCE DE LA PRÉSENCE DE 11 ESPÈCES DE TÉLÉOSTÉENS ORIGINAIRES DE L'OCÉAN ATLANTIQUE ET DE LA MÉDITERRANÉE OCCIDENTALE DANS LES EAUX DE SYRIE (MÉDITERRANÉE ORIENTALE)

Adib SAAD[1] et Miskal SBAIHI[2]

[1] Lab. Sciences de la mer, Fac. d'agriculture. Univ. de Tichrine, BP 1408 Lattaquie, Syrie
[2] Faculté des Sciences, Université de Tichrine, BP 1408, Lattaquie, Syrie

Les études concernant les poissons peuplant les eaux syriennes de la Méditerranée orientale sont très rares et incomplètes (GRUVEL, 1931; ANON, 1976; WHITEHEAD *et al.*,1986; FISHER *et al.*, 1987). Pour combler cette lacune, un programme de recherche a été engagé début 1991. Des prélèvements de poissons pêchés industriellement à l'aide d'un filet à perche appartenant à l'établissement de pêche de Lattaquie, ainsi qu'artisanalement par des pêcheurs professionnels ont été effectués de façon hebdomadaire sur une durée de 2 ans (avril 1991 - mai 1993). En outre, nous avons utilisé tous les engins et méthodes de pêche pratiqués par les pêcheurs locaux.

Les profondeurs où les poissons ont été pêchés, oscillent entre la surface et 300 mètres (quelquefois jusqu'à 600 mètres) couvrant la côte du département de Lattaquie (de la frontière avec la Turquie au Nord jusqu'à la ville de Banyas au Sud), soit environ 120 km.

Pour identifier les espèces pêchées, nous avons utilisé les clés d'identification internationales (WHITEHEAD *et al.*, 1986, FISHER *et al.*, 1987) en se basant principalement sur les caractères morphologiques et parfois anatomiques.

Dans ce travail, nous avons mis en évidence la présence de 58 espèces nouvelles qui s'ajoutent aux espèces déjà connues dans les eaux syriennes (ANON, 1976). Parmi celles-ci, 11 sont originaires de la partie occidentale de la Méditerranée et de la partie est de l'océan Atlantique (tableau 1). Ces espèces sont signalées pour la première fois non seulement sur la côte de Syrie, mais sur toute la côte Est de la Méditerranée (le bassin levantin) (MOUNEIMNÉ, 1978; BEN -TUVIA, 1983 in WHITEHEAD *et al.*, 1986; PAPACONSTANTINOU, 1988)

Des spécimens de chaque espèce ont été conservés au laboratoire des Sciences de la Mer de l'université de Tichrine (Lattaquie) selon la méthode préconisée par le laboratoire d'ichtyologie du Muséum National d'Histoire Naturelle de Paris.

D'autre part, cette étude a également montré la diminution importante et la disparition progressive de 5 espèces d'importance commerciale qui ont été abondantes par le passé dans cette région (*Belon belon, Dicentrarchus labrax, Dicentrachus punctatus, Sciaena umbra, Umbrina cirrosa, Sarpa salpa*).

En outre, nos résultats révèlent la présence d'espèces originaires de la mer Rouge qui n'étaient pas connues auparavant dans cette région de la Méditerranée. Vue l'importance de ce phénomène, ce dernier groupe fait l'objet d'une étude particulière. La présence de nouvelles espèces et la raréfaction d autres posent de nombreuses questions sur les facteurs qui sont à l'origine de ces phénomènes :

- variations climatiques ?
- changements hydrologiques (salinité, température, etc.) ?
- modification de la chaîne alimentaire, suite aux variations des facteurs précédents?
- surpêche ?

Ces différentes hypothèses sont discutées.

Tableau n°1: Espèces de poissons téléostéens originaires de la partie ouest de la Méditerranée et de l'est de l'océan Atlantique, pêchées et confirmées pour la première fois dans les eaux côtières de Syrie.

Familles	Espèces
APOGONIDAE	*1) Epigonus telescopus*
ARGENTINIDAE	*2) Argentina sphyraena*
	3) Glassanodon leioglossus
BRAMIDAE	*4) Brama brama*
CAPROIDAE	*5) Capros aper*
GOBIESOCIDAE	*6) Lapdogaster candollei*
GADIDAE	*7) Micromesistius poutassou*
	8) Gadiculus argenteus
HETERENCHELYIDAE	*9) Panturichthys fowleri*
OPHIDIIDAE	*10) Ophidion barbatum*
SPARIDAE	*11) Pagellus belottii*

RÉFÉRENCES

ANON. 1976. Inventaire des espèces de poissons dans les eaux Syriennes.Rapport de mission des experts Nords-Coréens en Syrie, août 1975-1976. Etablissement Générale de Pêche, Lattaquie, Syrie.

FISHER W., BOUCHOT M.L., SCHNEIDER M.,1987. Fiches FAO d'identification des espèces pour les besoins de la pêche, Méditerranée et Mer Noire, Zone de pêche 37, Volume II : 761 - 1530.

MOUNEIMNÉ N. 1977. Les poissons de la côte du Liban (Méditerranée orientale), *Cybium*, 3e série 1 : 37-66.

PAPACONSTANTINOU C.,1988. Fauna Graeciae, Check-List of marine Fishes of Greece, 251 P. Athens.

WHITEHEAD P.J.P., BOUCHOT M.L., HUREAU j.C., TORTONESE E. 1986. Fishes of North-eastern Atlantic and the Mediterranean sea. Ed.Unesco.Volumes II, III, PP. 517-1473.

V

CEPHALOPODS CAUGHT WITH TWO TYPES OF DRAGGED GEAR OFF THE CATALAN COAST (NORTHWESTERN MEDITERRANEAN)

Pilar SÁNCHEZ

Instituto de Ciencias del Mar. Paseo Joan de Borbó s/n, 08039 Barcelona, Spain

In experimental tows a comparison was made between two different types of fishing gear, the bottom-trawl and a special type of dragged gear, locally known as "rastell", in depths ranging from 3.3 to 28.8 m in the case of the "rastell", and from 21.6 to 37.8 m in the case of the bottom-trawl. Both were utilized in the same area (the ports of Vilanova and Sant Carles in the Spanish Mediterranean). In the course of these tows, four species of cephalopod were caught with both gears.

In spite of the fact that both gears trawl the sea bottom, the structure of each of them determines the type of species which they catch. The "rastell" is distinguished by a mouth formed by an oval or rectangular metal structure with a small aperture (1.5 m). Because it is fitted with chains, it is dragged along the bottom. The bottom-trawl is characterized by otter boards and a large mouth aperture (more than 3 m), and it is not in such firm contact with the bottom as the "rastell". In addition, the speed of fishing with the bottom-trawl is somewhat greater than is fishing with the "rastell". These features made it possible to establish the lower distribution limit of each species, as well as their behaviour.

Of the four species caught with the two gears, two are nektonic (*Loligo vulgaris* and *Alloteuthis media*), and two are benthonic (*Octopus vulgaris* and *Sepia officinalis*). *L. vulgaris* was very rarely caught with the "rastell" (2 tows out of 59) and quite frequently taken with the bottom-trawl (10 out of 19). *A. media*, the other nektonic species, appeared in practically all the hauls made with the bottom-trawl (17 out of 19), but was taken only sporadically with the "rastell" (13 out of 59). *O. vulgaris* was caught more frequently with the bottom-trawl (10 out of 19) than with the "rastell", while *S. officinalis* was found more often in the "rastell" hauls (34 out of 59) than in the bottom-trawl hauls (10 out of 19).

The frequency of appearance in the catches is shown in terms of the abundance ($kg^* h^{-1}$) of the species by fishing gear (Table 1). The two nektonic species present a very low mean biomass, although it was slightly higher in the hauls made with bottom-trawl than in those taken with the "rastell". The two benthonic species display a greater abundance, especially *O. vulgaris*; *S. officinalis* seems to be caught more efficiently with the "rastell" than with the bottom-trawl.

Given the difference in size of the adult individuals of the four species, and as a result in their weight, abundance in weight is not sufficient to provide a satisfactory picture of their abundance. For that reason, the number of specimens per hour of trawling was analyzed. The two nektonic species show a high mean number in those catches made with the bottom-trawl, which is not the case with the "rastell". The number of *O. vulgaris* caught is low and quite similar for the two gears, while the number of *S. officinalis* caught with the "rastell" is high.

There are several reasons which explain these results :

- 1) *A. media* and *L. vulgaris* are caught at the lower limit of their distribution (20 m), while the distribution of the two benthonic species is more coastal still, particularly that of the *S. officinalis*.
- 2) The nektonic species carry out daily migrations in which they are closer to the bottom during the daylight hours. This behaviour, together with the greater mouth size of the bottom-trawl, made it possible that, the nektonic specimens were more abundant in the catches obtained with this gear than in the "rastell" catches. The benthonic species closely linked to the sea bottom, particularly *S. officinalis*, which sometimes buries itself, are fished efficiently with both gears.
- 3) The number of specimens caught of each different species is a reflection of their behaviour. The nektonic species live together in schools, which is why, in spite of the sporadic nature of the catches and the fact that these gears are not ideal for their fishery, when they appear, they do so in relatively high numbers, particularly in the case of *A. media*. The benthonic species, especially *O. vulgaris*, are territorial and therefore live more dispersed. In spite of this, however, the number of *S. officinalis* taken with the rastell can be rather high.

		($kg*h^{-1}$) TRAWL	RASTELL	($no*h^{-1}$) TRAWL	RASTELL	DEPTH (m) TRAWL	RASTELL
	min	0.008	0.014	0.6	2.3	21.6	17.3
Loligo	max	1.644	0.042	73.0	4.7	36.9	23.8
vulgaris	mea	0.250	0.028	20.8	3.5	27.4	20.5
	std	0.472	0.014	24.1	1.2	4.4	3.3
	min	0.023	0.003	10.1	1.2	21.6	17.3
Alloteuthis	max	1.930	0.103	266.1	9.3	36.9	25.0
media	mea	0.672	0.046	97.1	4.6	27.0	22.0
	std	0.597	0.029	83.9	2.6	4.7	2.2
	min	0.021	0.006	1.0	0.7	21.6	6.0
Octopus	max	10.833	6.837	17.8	15.0	37.8	28.8
vulgaris	mean	3.680	1.612	7.9	5.2	31.6	18.6
	std	3.284	1.995	5.5	4.0	5.0	5.9
	min	0.090	0.028	1.0	0.8	21.6	3.3
Sepia	max	3.440	13.330	32.0	205.7	36.9	28.8
officinalis	mean	0.663	1.938	7.2	23.5	28.6	17.4
	std	0.951	3.364	8.7	43.9	5.3	6.8

Table 1. Abundances ($kg^* h^{-1}$ = kg per hour and $no^* h^{-1}$ = number of individuals per hour) of the four species caught with the conventional dragged gear and with the rastell, as well as the depths at which they were caught.

THE EXISTENCE OF 4 IMMIGRANT FISH SPECIES FROM THE RED SEA IN THE SYRIAN COAST (THE ORIENTAL MEDITERRANEAN)

Miskal SBAIHI[1] and Adib SAAD[2]

[1] Depart. Natural Sciences. Fac. of Sciences, University of Tishreen,
[2] Depart. Fundamentals Sciences. Fac. of Agriculture, University of Tishreen, Lattakia, Syria

In order to make an environmental and systematic survey on fishes in the Syrian coast, we begin in May 1991 to collect fish specimen directly from the sea by sailing with demersal trawl launches which belong to the marine fishing center in Lattakia, and with small and big boats which belong to fishermen. These boats and launches use many methods in fishing (long line, many kind of seines ...). Our voyages have covered all the region from the Turkish bounderies in the north to Banias city in the south.

Consequently, we have determined 150 species which belong to 112 genera which follow 69 families, which follow in turn 15 orders, which belong to the super order Teleostei.

In a very artistic and scientific way, we have preserved samples of these fishes insid glass vessels which are firmly closed in the laboratory of Oceanography and Aquatic Environment in Tishreen University. In our research, we have recorded the existence of 4 species for the first time in the Syrian regional water. Comparing the systematic properties with the modern systematics keys (WHITEHEAD *et al.*, 1986; FISHER *et al.*, 1987), we found that these species belong to the fishes of the Indian Ocean and the Red Sea. These fishes migrated to the Mediterranean through the Suez canal. Ben-Tuvia was the first to point to the migration of these species and to record their existence in the Mediterranean, in the southern Israelian coasts. We are not aware of any further evidence supporting the existence of these species in the Eastern Basin of the Mediterranean (PAPACONSTANTINOU, 1988; MOUNEIMNE, 1977).

This migration tooks place as a result of the environmental changes which happened to the Eastern Basin of the Mediterranean sea. The environmental characteristics of the Mediterranean water became so close of those of the Red Sea and this in turn explains the migration of these fishes toward east of the Mediterranean. Are there other reasons ?

Family	species	date	method of fishing	depth
Apogonidae	*Apogon taeniatus*	3/12/92	demersal trawl	45 m
Callionymidae	*Callionymus filamentosus*	1/7/93	demersal trawl	65 m
Cynoglossidae	*Synoglossus sinusarabici*	25/3/93	dynamite	3 m
Gobiidae	*Silhoueta aegyptia*	2/4/93	demersal trawl	45 m

Table 1 : Names of immigrant species, Family, Depth of caught, methods and date of fishing.

	A. taeniatus	*C. filamentosus*	*S. sinusarabici*	*S. aegyptia*
Total length C.m	10,5	10,8	12,5	11
Standard length C.m	9,3	8,2	11,7	8,8
Body depth C.m	3,4	1,5	3,7	1,8
Head length Cm	3,2	2,4	2,3	2,7
Eye diameter C.m	0,8	0,6	0,3	0,7
First dorsal fin rays	VII	IV	100	VI
Second dorsal fin rays	I+8	9	-	I+10
Anal fin rays	II+6	9	78	11
Scales in lateral series	25	-	-	26

Table 2 : Morphometric and meristic characteristics (We have taken the average of 5 indviduals)

REFERENCE

BEN-TUVIA A.,1978. Immigration of fishes through the Suez canal. *Fish bull*, 76 (1) : 24 -255

FISHER W., BOUCHOT M-L., SCHNEIDER M., 1987, Fiches FAO d'identification des espèces pour les besoins de la pêche, Méditerranée et mer Noire, Zone de pêche 37. Vol. 11 : 761 - 1530

MOUNEIMNE N., 1977. Les poissons de la côte du Liban (Méditerraneée orientale), *Cybium* 3e serie I : 37 - 66.

PAPACONSTANTINOU C., 1988. Fauna Graeciae, check-list of marine fishes of Greece. 251 p . Athens.

WHITEHEAD P.J.P. , BOUCHOT M -L., HUREAU J-C., NIELSEN J., TORTONESE E., 1986 . Fishes of the North-eastern Atlantic and the Mediterranean, Ed. Unesco. Vol. I, II, III. 1473 p.

V

FIRST DATA ON SOME ASPECTS OF BIOLOGY AND POPULATION DYNAMICS OF ATLANTIC MACKEREL, *SCOMBER SCOMBRUS* L. IN THE ADRIATIC

Gorenka SINOVCIC

Institute of Oceanography and Fisheries, Split, Croatia

The paper presents the study of some aspects of biology and population dynamics of Atlantic mackerel, Scomber scombrus L.,from the Eastern Adriatic . Biometry, vertebral counts, age, growth, weight-length relationship, as well as first sexual maturity and sexual cycle were obtained from material sampled monthly during 1991-1993 period.

A total of 1 017 analyzed specimens of Scomber scombrus were sampled from commercial landings. Data of Atlantic mackerel length referring to their total (L_t), standard (L_s) and fork (L_f) lengths are expressed in centimetres, weight (W) in grams. The vertebrae were counted by lens, from occipital condyle (not counted) to urostyle, included. Mean length-at-age values were estimated from sagitta readings.

Atlantic mackerel mean lengths ranged from 12.2 to 40.1 cm L_t (Tab. 1).

Age	0+	1+	2+	3+	4+	5+	6+	7+	8+
$\bar{x}$ **L_t**	12.2	21.5	29.7	34.0	36.2	37.6	38.7	39.6	40.1

Table 1. *Scomber scombrus* - Average length per age

The relations of total length (L_t) to standard length (L_s) and vice versa, of total length to fork length (L_f) and vice versa, are best described by the following equations:

$$L_t = 1.0560\ L_s - 1.0693\ ;\ L_s = 0.9430\ L_t - 0.7437,\ r=0.998,\ P<0.001$$

$$L_t = 1.0510\ L_f + 0.8022\ ;\ L_f = 0.9507\ L_t - 0.7437,\ r=0.999,\ P<0.001$$

A count of 30 vertebrae was recorded in all specimens; a single variant had 29 vertebrae.

The weight (W) - length (L) relationship was calculated by the equation:

$$\log W = 3.604 \log L_t - 2.9567$$

or in arithmetic transformation:

$$W = 0.0011\ L_t^{3.604}$$

A positive allometry was established (b = 3.604).

Atlantic mackerel life span was 0 to 8+ years from the collected material.

The following growth parameters were derived for the mackerel stock :

$$L_{oo} = 42 \text{ cm}\ ;\ K = 0.37 \text{ year}^{-1};\ t_o = -0.5$$

Scomber scombrus attained sexual maturity at the end of the first year of life. Ripe mackerel specimens were found from January to April with the maximum in February. The condition and fatness of mackerel individuals are affected by the gonad cycle.

Approximately, equal sex frequency distribution was recorded in total, with the predominance of males during spawning and females during the inactive phase of their sexual cycle.

RECENSEMENT DES POPULATIONS DE CÉTACÉS AUTOUR DE LA CORSE

Nelly TERRIS et Denise VIALE

CEVAREN, Laboratoire d'écologie méditerranéenne, Faculté des Sciences et techniques, Université de Corse, 20250 Corte, France

Avec la collaboration de toute l'équipe Médicet

Les estimations de populations de cétacés réalisées autour de la Corse sont rares (VIALE, 1977; DINTHEER, 1982). Aussi, l'équipe Médicet (laboratoire d'écologie méditerranéenne, Université de Corse) a-t-elle organisé une première journée de recensement le 30 mai 1993. Ce recensement permet d'avoir une estimation annuelle des populations de cétacés en Corse, et plus particulièrement du *Tursiops truncatus*.

Il a été réalisé dans la zone côtière jusqu'à 5 milles des côtes grâce à des observateurs et plaisanciers bénévoles. Nous avons effectué un comptage selon la méthode du *"line transect"* (HOLT, 1981; WARD et HIBY, 1987) sur l'ensemble des côtes pendant une journée,ce qui nous a permis d'éviter de compter plusieurs fois les mêmes individus. 19 bateaux avec des observateurs formés au préalable ont prospecté une grande partie du pourtour de l'île dans la zone côtière de 0 à 5 milles. De plus, certains sémaphores nous ont fourni leurs observations de la côte. Une régate, organisée ce jour-là, nous a permis de récolter des données supplémentaires au-delà de la zone des 5 milles côtiers. La vigie a été réalisée dans des conditions favorables (B<4, mer belle à peu agitée) sauf à la pointe nord du cap Corse où la mer était agitée.

Résultats bruts du recensement du 30 mai 1993

Espèces	Observations des régatiers (> 5 milles)	Observations côtières en mer (< 5 milles)	Observations des sémaphores (< 5 milles)
Tursiops truncatus (Tt)		84-99	
Delphinus delphis (Dd)	4-10 4-10 50-60 (dont Sc)		7
Stenella coeruleoalba (Sc)			5-10
Dauphins non identifiés		9	
Grampus griseus (Gg)		4-5	
Balaenoptera physalus (Bp)	1		
TOTAL	**58-80 dauphins** **1 rorqual**	**97-113 dauphins**	**12-17 dauphins**

N. B : Nous prendrons en compte les chiffres les plus grands de chaque dénombrement. En effet, pour les comptages de petits cétacés, les observateurs ont tendance à sous-évaluer le nombre d'individus présents (SCOTT et al., 1982).

Dans la zone des 5 milles, les 19 bateaux ont parcouru au total 648 milles avec une vigie assurée par les observateurs. Pour les sémaphores, nous estimons une surface d'observation de 69 milles^2. La surface ainsi étudiée représente donc 648 milles^2, en considérant un ruban de 1 mille de large pour l'observation de petits cétacés (BALCOMB *et al.*, 1980). Au total, dans la zone des 5 milles, nous obtenons un indice d'abondance (TERRIS, 1990 et 1992; VIALE, 1991) de 0,181 individu/mille^2 en vigie. Les *Tursiops truncatus* constituent 76,15% des cétacés observés dans la zone des 5 milles, ce qui confirme bien le comportement néritique de cette espèce. Les résultats acquis par les régatiers concernant une zone plus au large (jusqu'à 11 milles) permettent de recenser des *Delphinus delphis*, des *Stenelle coeruleoalba* et un *Balaenoptère physalus* ou rorqual commun. En ce qui concerne la répartition des cétacés autour de la Corse le 30 mai 1993, 56% des individus (52% des *Tursiops truncatus)* ont été détectés dans le sud de l'île contrairement aux fortes concentrations observées dans le nord par PILLERI ET PILLERI (1987).

Le 30 mai 1993, nous avons pu observer : 99 *Tursiops truncatus*, 7 *Delphinus delphis*, 10 *Stenella coeruleoalba,* 5 *Grampus griseus* et 9 dauphins non indentifiés pour la zone étudiée (environ 70 milles de côtes n'ont pu être couverts faute de bateaux dans deux secteurs). Ces résultats sont comparables aux données antérieures, aux différences de méthodes près : 82 cétacés détectés en comptage aérien (DINTHEER, 1982), ce qui restreint la détection des petits individus et une estimation des pêcheurs de 225 *Tursiops truncatus* présents sur les cantonnements de pêche (VIALE, 1977). Il semblerait donc que la Corse conserve un niveau satisfaisant de cétacés.

Les pêcheurs jugent notre comptage sous-estimé, d'où la nécessité de renouveler ce type de recensement dans des conditions similaires afin de vérifier ce premier résultat.

REFERENCES

BALCOMB K.C. *et al.*, 1980. Estimation of Humpack initiale population in the north western Alantic in 1980. Oregon State University. Sea Grant College Program. *Marine Mammals Information*, Dec. 1980 : 11.

DINTHEER C., 1982. Distribution des grands pélagiques autour de la Corse. Campagne de prospections aériennes. *Science et pêches; Bull. Inst. Pêches marit.* 322 : 14 p.

HIBY A.R., 1985. An approch to estimating population densities of Great whales from sighting surveys. *IMA journal of Mathematics Applied in Medicine and Biology.* 2 : 201-220.

HOLT R. S., 1981. Use of the line transect methods to estimate dolphin population abundance in large survey areas. Oregon State University. *Marine Mammals Information.* Dec. 1981 : 16.

PILLERI G., PILLERI O., 1987. Records of cetaceans in the Mediterranean sea and north Atlantic ocean, in the period 1982-1986. *Investigations on cetacea*, edited by PILLERI G. Vol. XX : 267-280.

SCOTT G.P. *et al.*, 1982, Multispecies aggregation in the western north Atlantic. Oregon State University. *Marine Mammals Information.* Juil. 1982 : 42.

TERRIS N., 1990. Répartition des cétacés en Méditerranée nord-occidentale. Evaluation quantitative de leur biomasse par l'utilisation d'un indice d'abondance comparatif. Rapport de DEA "Environnement marin. Connaissance. Valorisation. Adaptation". Université d'Aix-Marseille III. Sept. 1990. 40 p.

TERRIS N., 1992. Abondance de cétacés : variations saisonnières en Méditerranée et Atlantique en 1991. *Rapp. Com. Inter. Mer Médit.* 33.

VIALE D., 1977. Ecologie des cétacés en Méditerranée sud-occidentale : leur place dans l'écosystème, leur réaction à la pollution marine par les métaux. Thèse d'Etat. Université Pierre et Marie Curie, Paris VI. 312 p.

VIALE D., 1991. Une méthode synoptique de recherches des zones productives en mer : détection simultanée des cétacés, des fronts thermiques et des biomasses sous-jacentes. *Ann. Inst. Océanogr.* 67 (1) : 49-62.

WARD A.J., HIBY A.R., 1987. Analysis of cue-counting and blow rate estimation experiments carried out during the 1985-1986 IWC/IDCR Minke whale assessment cruise. *report Int. Whal. Commn.* 37 : 259-262.

V

À PROPOS DES RELATIONS STOCK-RECRUTEMENT

Suzanne TOUZEAU et Jean-Luc GOUZE
INRIA. BP 93. 06902 Sophia-Antipolis Cedex, France

Lorsqu'en pêche, on souhaite modéliser l'ensemble du cycle vital des poissons, il est nécessaire d'exprimer le recrutement (i.e. l'entrée dans la phase exploitable). Certains modèles font appel à un recrutement constant ou purement stochastique. Une autre manière de faire est d'introduire une relation stock-recrutement, qui détermine le recrutement à partir de l'effectif ou la biomasse du stock fécond. Les deux relations classiques les plus utilisées sont celles de Ricker, et de Beverton et Holt (CLARK, 1976). Cependant, les comparaisons entre ces relations et les données expérimentales sont souvent décevantes (HILBORN et WALTERS, 1992). Pour clarifier ces modèles, nous avons modélisé la dynamique de la phase pré-recrutée. En première approche, nous considérons que l'effort de pêche est maintenu constant et intégré dans le terme de mortalité. Nous avons choisi un modèle en temps continu, structuré en (n+1) stades représentés par leur effectif x_i, le premier stade x_0 étant la phase pré-recrutée (œufs, larves, juvéniles).

$$x_0' = -a\,x_0 - m_0\,x_0 + \sum_{i=1}^{n} f_i\,l_i\,x_i - \sum_{i=1}^{n} p_i\,x_i\,x_0) - p_0\,(x_0)^2$$

$$x_i' = a\,x_{i-1} - a\,x_i - m_i\,x_i \qquad (i = 1,\ldots,n)$$

Chaque stade i (1 à n) du stock est soumis à mortalité (mort naturelle et pêche: m_i) et passage (α). Le premier stade d'effectif x_0 est aussi soumis à mortalité (m_0) et passage dans la classe supérieure; le nombre d'œufs (par unité de temps) introduits dans le stade 0 est donné par la somme des ($f_i\ l_i\ x_i$), où f_i est la proportion d'individus féconds, et l_i le nombre moyen d'œufs émis par un tel individu. Les juvéniles sont aussi éventuellement soumis à de la prédation parentale du stade i ($p_i\ x_i\ x_0$) et de la compétition ($p_0\ x_0^2$).

Relation stock-recrutement ? A partir de simulations, nous avons représenté le recrutement instantané: $r(t)=a x_0(t)$ en fonction du stock fécond à cet instant : $x_f(t) = \sum f_i\ x_i(t)$) (figure ci-dessous).

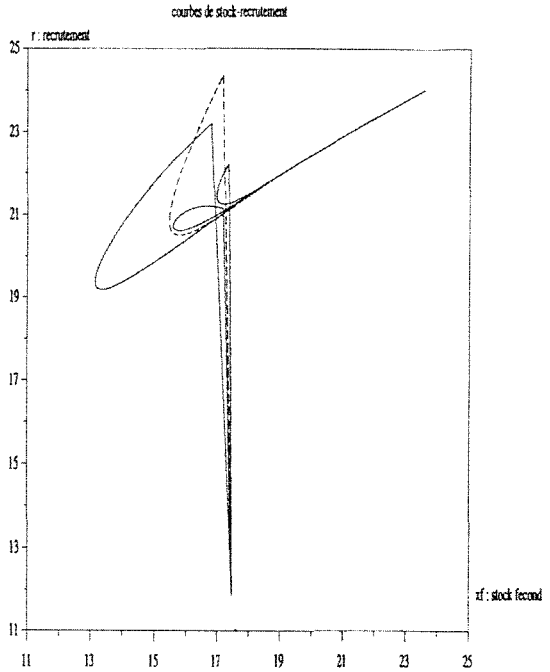
On remarque que pour un jeu de paramètres donné :
- cette "relation stock-recrutement" n'est pas une fonction : à un stock fécond donné correspondent plusieurs recrutements possibles,
- elle dépend fortement des conditions initiales; il existe plusieurs répartitions dans les stades du stock donnant un même point initial sur le graphique : (x_f,r).

La seule manière de retrouver une relation biunivoque stock-recrutement est de faire les hypothèses très restrictives suivantes:
- dynamique sur les juvéniles très rapide;
- pour tout i: f_i=f, p_i=p, l_i=l, sauf pour certains indices où tous ces coefficients sont nuls.

On obtient alors une courbe d'allure semblable à celle de Beverton et Holt.

Extensions. Pour mieux intégrer la pêche dans notre modèle, on peut introduire au niveau des termes de mortalité, un terme de contrôle dépendant du temps : l'effort de pêche E(t), tel que: $m_i = m_i' + q_i\ E(t)$ où: m_i' repésente le taux de mortalité naturelle et q_i la capturabilité du stade i. Par ailleurs, la pêche étant un phénomène saisonnier, on peut introduire au niveau des termes ($l_i\ f_i\ x_i$) une variable forçante périodique s(t), de période une année. On obtient ainsi une saison de ponte de durée τ dans l'année, en dehors de laquelle aucun œuf n'arrive en phase pré-recrutée.

On peut alors définir une notion de recrutement intégré sur une année et de stock fécond moyen, qu'il est plus facile de comparer avec les données expérimentales.



RÉFÉRENCES

CLARK C.W., 1976. Mathematical bioeconomics: the optimal management of renewable resources. Pure and Applied Mathematics. Wiley.

HILBORN R. et WALTERS C. J., 1992. Quantitative fisheries stock assessment: choice, dynamics & uncertainty. Chapman and Hall. pp 243-268

LAUREC A. et LE GUEN J.-C., 1981. Dynamique des populations marines exploitées - Tome 1: Concepts et modèles. Rapports scientifiques et techniques 45. CNEXO. (cf éditions de l'IFREMER)

MICROZOOPLANCTON AND FEEDING OF ANCHOVY LARVAE IN NORTHWESTERN MEDITERRANEAN

S. TUDELA and I. PALOMERA
Institut de Ciències del Mar, P. Joan de Borbó, s/n. 08039, Barcelona, España

In 1992, spawning season of anchovy (*Engraulis encrasicolus*), samples of microzooplankton were taken simultaneously with ichthioplankton samples in order to detect favorable areas for the anchovy larval survival, in the area covering Catalan sea, Gulf of Lions and Ligurian sea. Samples of microzooplankton were taken with a 15 cm diameter Bongo fitted with conical nets of 53 µm, attached at the same wire that the 40 cm diameter bongo used for sampling ichthyoplankton. We analized dry weight, organic matter and ashes of 193 samples of microzooplankton. Samples were defrosted and filtered with a mesh of 53 µm. Organisms bigger than 1 cm were eliminated of the analysis. Later the samples were dried in a stove at constant temperature of 70°C during 24 hours in order to secure total dry. After 4 hours in a dessicator, samples were weigthed, with a precision of 1 mg. Afterwards this samples were introduced in a oven at a temperature of 500°C during 1 hour. Ashes were weighted with a precision of 1 mg. Contents of organic matter was then obtained by the difference between dry weight and ashes weight. Composition of different groups of microzooplankton was analysed in samples of 39 stations including two complete transects perpendicular to the coast south (transect 14) and middle Gulf of Lions (transect 20). The gut content of 228 anchovy larvae obtained by the 40 cm bongo net in selected stations along the catalan coast and gulf of Lions was studied. Anchovy larvae were measured with an eyepiece micrometer and afterwards the guts were removed and opened. The contents were identified, counted and copepod developmental stages measured (mm). Maximum concentrations of organic matter were found at Gulf of Lions, with a maximum around 20 mg/m^3 at a coastal area near Cap d'Agde. Generaly the values over the Gulf were high and we can see two more high values in the central area (11 mg/m^3) and near the mouth of the Rhone river. Going to the south the values were lower until the delta of the Ebro river with a maximum of 12 mg/m^3. At the Ligurian sea, the values were generally lower, only a maximum of 11 mg/m3 in front of Livorno. (Fig. 1). In fact, maximum values coincide with areas of lower salinities in the zones of outflow of rivers. Anchovy larvae were found near the shelf break (GARCIA, 1994) in areas where the values of microzooplankton were relatively high. Nauplii and copepodites were the dominant components of microzooplankton, and were also important cladocers. Other potential preys for anchovy larvae were present but in less important numbers.

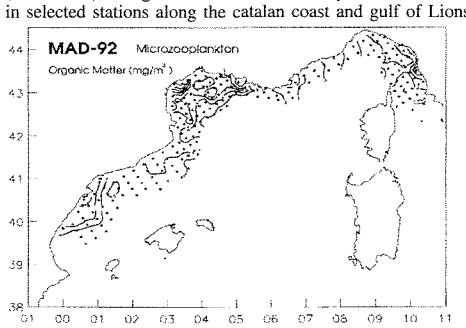
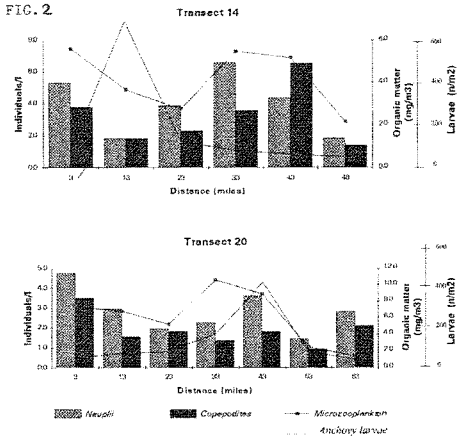


FIG. 2



Distribution of abundances in the two transects analized (Fig. 2) showed that values of microzooplankton are high at stations near the shelf break, coinciding in transect 20 with larvae maxi-mum, and that the values of nauplii/l were closed to those of organic matter, while copepodites manteined similar values in all stations. The size range of larvae studied for feeding aspects was 3.59 to 13.33 mm SL. Only the 10.52% of the larvae examined had food in their gut. The size range of larvae with food in the gut was 5.33 to 11.59 mm SL. The mean number of particles per feeding larvae was 1.83. The main dietary components were eggs, naupliar and copepodite stages of copepods. Copepod eggs were the 29.5% of the preys, nauplius the 27.2% and copepodites de 31.8%. Other items in the diet were cladocers, pollen of gymnosperms and other organic particles not identified. Cladocers were the bigger preys detected. Measures of the maximum width of preys showed that maximum prey size increases with larvae size. Nevertheless the range of prey size also increases (Fig. 3) meaning that larger larvae feed on larger prey but continues feeding small preys.

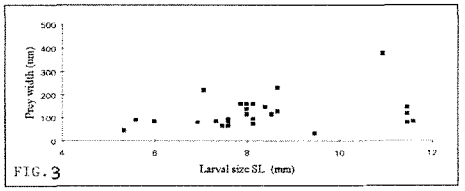


FIG. 3

REFERENCES

GARCIA, A. *et al.*, 1993.-Northwestern Mediterranean anchovy. Distribution, biology, fisheries and biomass estimation by different methods. Final Report Study Contract FAR Project MA 3.370. U.E. DG XIV.

V

ANALYTICAL MODELS FOR MEDITERRANEAN SPECIES : AN APPLICATION ON THE *HELICOLENUS DACTYLOPTERUS* (DELAROCHE) RESOURCE IN THE LOWER ADRIATIC

N. UNGARO and G. MARANO

Laboratorio di biologia marina, Molo Pizzoli (Porto), 70123 Bari, Italy

The Bluemouth Rockfish is one of the most abundant demersal species in the trawl fishery on bathyal bottoms of the lower Adriatic (MARANO *et al.*,1977; AA.VV,1993). The biology of the species has been widely studied in Italian waters (PEIRANO & TUNESI, 1986; RAGONESE, 1989, D'ONGHIA *et al.*, 1992), whereas little has been written on its exploitation (RAGONESE & REALE, 1992). This note tries to provide an insight by means of classic analytical models into the possibile exploitation of the species . Such an application in the case of the mediterranean Bluemouth Rockfish (a teleostean with a mainly bathyal distribution, thus present in an area characterized by stable environmental characteristics), presupposing constant recruitment, can provide reliable and comparable information.

The biological data relative to the species were obtained during trawl-surveys in the lower Adriatic (between -20 and -700m) in the autumn of 1992 and the spring of 1993 (AA.VV., 1993). Sampling was carried out using a trawl net (stretched mesh = 35mm) randomly at 25 stations (one hour of fishing) for each fishing survey. The samples collected were all measured (LT, cm), weighed (g) and the otoliths extracted in order to calculate the growth parameters.

The data collected have made it possible to obtain the size distribution, C.P.U.E. estimate (Kg/h), to formulate the lenght- weight relationship and the growth curve, and therefore to estimate all the parameters necessary for the application of the Beverton & Holt (Y/R) and Thompson & Bell (SPARRE, 1987) models.

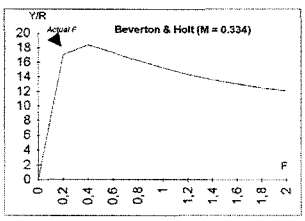
The models were applied to the fished stock without differentiation for sex (UNGARO *et al.*, 1994); the following growth parameters (Brody-von Bertalanffy curve) were obtained (UNGARO *et al.*, in prep.): Linf. =29.90 cm, K =0.19, t0 = -0.85 years. The coefficients of the lenght-weight relationship were: a=0.0208, b=2.917.The size of the first catch (LC50%) and that of recruitment were 8.75 cm and 5 cm respectively. The total mortality (Z) was estimated using the "catch curve" (PAULY, 1984) and the Jones & Van Zalinge method (JONES, 1984) with respective values of 0.57 and 0.60. The natural mortality (M), a parameter the estimate of which proved otherwise problematic (VETTER, 1988), was evaluated using the empirical fomula of Djabali (DJABALI *et al.*, in press), assuming the average temperature in the distribution area to be 13.5°C, and using the Chen & Watanabe method (CHEN & WATANABE,1989); the respective values were 0.334 and 0.28, both falling within the usually accepted range for this type of organism. Considering the similarity between the total mortality values obtained using the two methods, Z=0.57 was adopted. In the case of natural mortality, the difference between the obtained values using the two methods appears more marked and so it seemed sensible to plot two distinct Y/R curves (figs1-2). A value of M=0.28 is used for the Thompson & Bell model (fig. 3). The average fishing mortality (F) of the species Helicolenus dactylopterus in the Lower Adriatic in the period autumn 1992-spring 1993 was between 0.24 and 0.29, depending on the value of M chosen.

The same actual value of F, reported on the curves obtained from the models considered, seems in all cases to be very close to that reccomended for the optimal exploitation of the teleostean in question. It is important to note that of the two models that of Beverton & Holt proved gave the most conservative results.

ACKNOWLEDGEMENTS. The authors would like to thank Roberta Marsan for collaboration in data input.

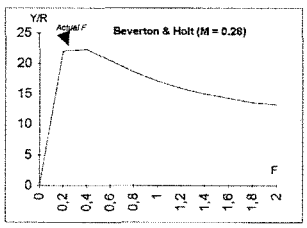
REFERENCES

AA.VV., 1993. Demersal Resources Assessment: Southern Adriatic, 1990-93. Min. Mar. Merc., Rome.
CHEN S. and WATANABE S., 1989.- *Nippon Suisan Gakkaishi*, 55(2): 205-208.
D'ONGHIA G., MATARRESE A., TURSI A., 1992.- *Oebalia*, XVII(Suppl.): 129-131.
DJABALI F., MEHAILIA A., KOUDIL M., BRAHMI B., in press.-*Naga Revue.*
JONES R., 1984.- *FAO Fish. Tech. Pap.*, 256: 118 pp.
MARANO G., CASAVOLA N., VACCARELLA R., PAGANELLI A., 1977.- *Oebalia*, 3: 17-31.
PAULY D., 1984.- *ICLARM Studies and Reviews*, 8: 325 pp.
PEIRANO A. and TUNESI L., 1986.- Rapp. Comm. Int. Mer Medit., 30(2): 233.
RAGONESE S., 1989.- *Oebalia*, XV(2): 753-762.
RAGONESE S. and REALE B., 1992.- Rapp. Comm. Int. Mer Medit., 33: 307.
SPARRE P., 1987.- *FAO Fish. Tech. Pap.*, 101(2): 218 pp.
UNGARO N., RIZZI E., MARZANO M.C., 1994.- *Biologia Marina Mediterranea*, 1: 317-318.
VETTER E.F., 1988.- *Fish. Bull.*, 86(1): 25-43.



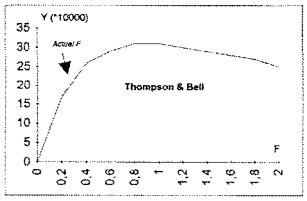
Fmax=0,3 MSY/R=18,44
F0,1=0,2 Y/R for F0,1=17,2

figure 1



Fmax = 0,29 MSY/R = 22,8
F0,1 = 0,17 Y/R for F0,1 = 21,3

figure 2



MSY = 307301

figure 3

ANALYTICAL MODELS FOR MEDITERRANEAN SPECIES : AN APPLICATION ON THE *LEPIDORHOMBUS BOSCII* (RISSO) RESOURCE IN THE LOWER ADRIATIC

N. UNGARO and G. MARANO

Laboratorio di biologia marina, Molo Pizzoli (Porto), 70123 Bari, Italy

The Fourspotted scaldfish is one of the most valuable species in the trawl fishery of the Lower Adriatic, aboveall that carried out on the bathyal bottoms (MARANO *et al.*,1977; AA.VV.,1993). Some aspects of the biology of the area in question have been studied recently (BELLO & RIZZI,1988). This note tries to provide an insight by means of classic analytical models into the possible exploitation of the species. Such an application in the case of the mediterranean Fourspotted scaldfish (a teleostean with a mainly bathyal distribution, thus present in an area characterized by stable environmental characteristics), presupposing constant recruitment, can provide reliable and comparable information.

The biological data relative to the species were obtained during trawl-surveys in the lower Adriatic (between -20 and -700m) in the autumn of 1992 and the spring of 1993 (AA.VV., 1993). Sampling was carried out using a trawl net (stretched mesh = 35mm) randomly at 25 stations (one hour of fishing) for each fishing survey. The samples collected were all measured (LT, cm), weighed (g) and the otoliths extracted in order to calculate the growth parameters.

The data collected have made it possible to obtain the size distribution, C.P.U.E. estimate (Kg/h), to formulate the lenght-weight relationship and the growth curve, and therefore to estimate all the parameters necessary for the application of the Beverton & Holt (Y/R) and Thompson & Bell (SPARRE, 1987) models.

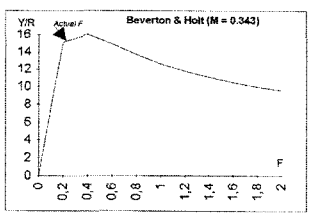
The models were applied to the fished stock without differentiation for sex (UNGARO *et al.*, 1994); the following growth parameters (Brody-von Bertalanffy curve) were obtained (UNGARO *et al.*, in preparation) : Linf. =35.45 cm, K =0.20, t0 = -0.47 years. The coefficients of the lenght-weight relationship were: a=0.0029, b=3.302.The size of the first catch (LC50%) and that of recruitment were 9.38 cm and 6 cm respectively. The total mortality (Z) was estimated using the "catch curve" (PAULY, 1984) and the Jones & Van Zalinge method (JONES, 1984) with respective values of 0.60 and 0.58. The natural mortality (M), a parameter the estimate of which proved otherwise problematic (VETTER, 1988), was evaluated using the empirical fomula of Djabali (DJABALI *et al.*, in press.) , assuming the average temperature in the distribution area to be 13.5°C, and using the Chen & Watanabe method (CHEN & WATANABE,1989); the respective values were 0.343 and 0.30, both falling within the usually accepted range for this type of organism. Considering the similarity between the total mortality values obtained using the two methods, Z=0.60 was adopted. In the case of natural mortality, the difference between the obtained values using the two methods appears more marked and so it seemed sensible to plot two distinct Y/R curves (figs1-2). A value of M=0.30 is used for the Thompson & Bell model (fig. 3). The average fishing mortality (F) of the species *Lepidorhombus boscii* in the lower Adriatic in the period autumn 1992-spring 1993 was between 0.25 and 0.30, depending on the value of M chosen.

The same actual value of F, reported on the curves obtained from the models considered, seems in all cases to be very close to that reccomended for the optimal exploitation of the teleostean in question. It is important to note that of the two models that of Beverton & Holt proved gave the most conservative results.

ACKNOWLEDGEMENTS : The authors would like to thank Roberta Marsan for collaboration in data input.

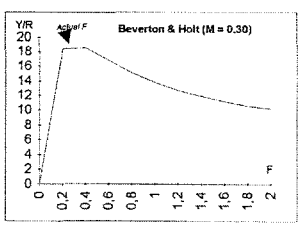
REFERENCES

AA.VV., 1993. Demersal Resources Assessment: Southern Adriatic, 1990-93. Min. Mar. Merc., Rome.
BELLO G. & RIZZI E., 1988.- *FAO Fish. Rep.*, 394: 142-146.
CHEN S. & WATANABE S., 1989.- *Nippon Suisan Gakkaishi*, 55(2): 205-208.
DJABALI F., MEHAILIA A., KOUDIL M., BRAHMI B., in press.- Naga revue.
JONES R., 1984.- *FAO Fish. Tech. Pap.*, 256: 118 pp.
MARANO G., CASAVOLA N., VACCARELLA R., PAGANELLI A., 1977.- *Oebalia*, 3: 17-31.
PAULY D., 1984.- *ICLARM Studies and Reviews*, 8: 325 pp.
SPARRE P., 1987.- *FAO Fish. Tech. Pap.*, 101(2): 218 pp.
UNGARO N., RIZZI E., MARZANO M.C., 1994.- *Biologia Marina Mediterranea*, 1: 317-318.
VETTER E.F., 1988.- *Fish. Bull.*, 86(1): 25-43.



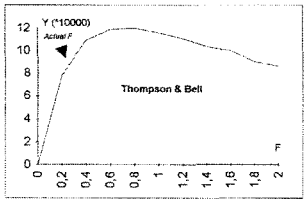
Fmax = 0,33 MSY/R = 16,1
F0,1 = 0,2 Y/R for F0,1 = 15,1

figure 1



Fmax = 0,29 MSY/R =19
F0,1 = 0,18 Y/R for F0,1 = 17,8

figure 2



MSY = 120913

figure 3

SEXUAL MATURITY OF THE STRIPED MULLET (*MULLUS SURMULETUS*) IN THE AEGEAN SEA

V. VASSILOPOULOU and C. PAPACONSTANTINOU
National Centre for Marine Research, Hellinikon 16604, Greece

Striped mullet is a demersal fish species distributed throughout the Mediterranean Sea and presenting a high commercial value. Few studies exist concerning the age and growth of the species (GHARBI & KTARI, 1981; ANDALORO & PRESTIPINO-GIARRITTA, 1985; MORALES-NIN, 1986; VASSILOPOULOU & PAPACONSTANTINOU, 1991), while there are no data on its sexual maturity. The aim of this study is to provide information on the period of reproduction, the length at first maturity (L_{50}) and the sex ratio of the striped mullet in Greek waters.

Sampling was carried out seasonally in the Aegean Sea in 1991-1992, using a 500HP commercial trawler having a cod-end mesh size of 14mm from knot to knot. In 402 specimens, fork length (FL) to the nearest millimetre, weight to the nearest gram and sex were recorded. Gonadal maturity was determined according to Nikolsky's scale (1976) (Stage I: juvenile immature gonads; II, III: adult immature; IV, V: mature; VI: spent). From Figure 1, it is obvious that the sexual maturity process begins in early spring, peaks in late spring-early summer and is completed in late summer, since in September only one specimen, whose gonads were at spent condition was collected, the rest being immature (mainly stage II).

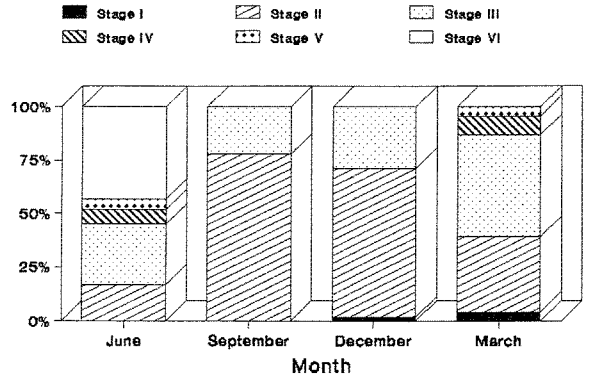


Fig. 1. Maturity stages of the striped mullet gonads collected seasonally in the Aegean Sea.

The length at first maturity was calculated according to ASHTON (1972) and GUNDERSON (1977) and was found to be L_{50}=103.8 mm FL for males and L_{50}=135. 1 mm FL for females. Hence, taking also into account our results on the age and growth of the species (VASSILOPOULOU & PAPACONSTANTINOU, 1991), it appears that the males mature at least one year earlier (at age 1 year) than females (at age 2 years). The earlier onset of maturity in males could be a factor influencing their growth rate, which is slower than that of females, in ages greater than 1 year. The application of x^2-test revealed that males were significantly more numerous than females in June and September, while in December and March the domination of males was statistically insignificant (Table 1). In relation to size, males outnumbered females till 180 mm (Fig. 2), then females were encountered more frequently, dominating completely in sizes larger than 230 mm FL.

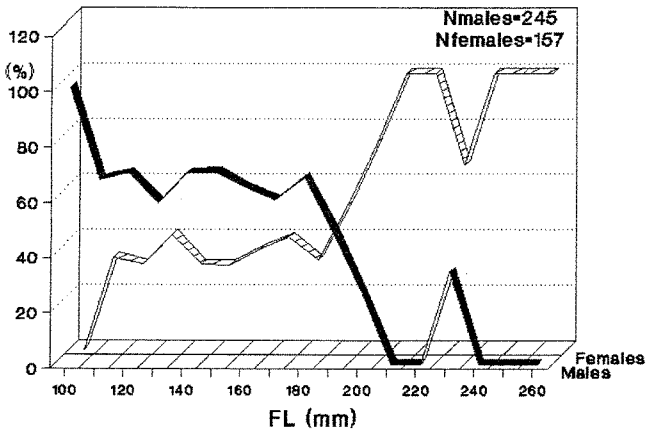


Fig. 2. Sex-ratio (%) of the striped mullet in each size interval.

	Males	Females	x^2	P
June	94	60	4.84	‹0.05
Sept.	44	18	17.64	‹0.001
Dec.	74	56	1.96	›0.05
March	33	23	3.24	›0.05

Table 1 : Number of males and females in the 4 sampling months, with x^2 test and probability level values.

REFERENCES

ANDALORO F. and S. PRESTIPINO-GIARRITTA, 1985. *FAO Fish. Rep.*, 336 : 89-92.
ASHTON W. D. 1972. Haffner Publ. N.Y., 88pp.
GHARBI H. & M. H. KTARI, 1981. *Bull. Inst. Nat. Sci. Tech. Oceanogr. Peche*, Salambo, 8 : 5-40.
GUNDERSON D. R., 1977. *Fish. Bull.*, 75(2) : 369-403
MORALES-NIN B., 1986. Rapp. P. V. Reun. CIESM, 30(2) : V-IV 3.
Vassilopoulou, V. & C. Papacontantinou, 1991. *FAO Fish. Rep.*, 447 : 85-96.

MEDASSET'S RESEARCH PROJECTS AROUND THE MEDITERRANEAN (1990-1994)

Lily VENIZELOS
MEDASSET, 1c Licavitou street, 10672 Athens, Greece

One of MEDASSET's prime objectives is the concerted effort to thouroughly survey the coastal areas of the Mediterranean in order to identify the presence of sea turtle (Loggerhead, *Caretta caretta*, and Green, *Chelonia mydas*) in these areas. Specific ecology of the coastal regions is logged as turtles cannot be successfully protected unless all their reproductive habitat is known. Recommendations for implementation of protective measures are made to the states involved if any important ecosystems or turtle nesting sites are found.

A. The coastal area of the North Aegean Sea, mainland and islands, totalling 2,000km was surveyed in 1991. Beach types and hind-beach sand dunes were documented. No significant turtle nesting was found in the region, probably due to unfavourable climatic conditions in the North of the Mediterranean. However, a large non-nesting population was present at sea. (Co-funded by the EC).

B. Nesting site and sand dune assessment of Sardinia, covering 750 km of coast, with emphasis on the Gulf of Orosei was undertaken in 1990 and 91. The reported exploitation of marine turtles was also investigated. Turtle nesting in the Western Mediterranean is almost non-existent nowadays. The aim of the project was to discover whether Sardinia was a final nesting possibility in this area of the Mediterranean. However, tourism had almost completely overrun the beaches making nesting almost impossible. A continuing presence of adult and sub-adult Loggerhead off shore was confirmed but no evidence of turtle nesting was found. (co-funded by the EC).

C. The first ever survey of Syria's 200 km coast was undertaken in 1991, investigating the possible occurrence of nesting sea turtles. The Syrian Coast is possibly the most polluted in the Mediterranean, with plastic waste covering much of the beach splash zone and raw sewage being piped directly into the sea. Despite of this a turtle nesting presence was discovered. Indeed one beach, between Jeble and Latakia, was found to contain a concentration of nesting activity but all nests had suffered from complete predation, probably due to humans. Protection of this beach region from touristic or industrial development is recommended. (Co-funded by HCI [UK] and MEDASSET).

D. In 1993, Phase I of surveying the Egyptian Mediterranean coast, from Alexandria to El Salum, was completed. These 600 km of coast was documented according to its physical and biological characteristics. Loggerhead turtles were found to nest there in small numbers. This was the first documented occurrence of marine turtles nesting in this area. Pollution was rife in some localities and touristic development is progressing rapidly, both are threatening to destroy some ecologically unique and important coastal regions. (Co-financed by MEDASSET, RAC/SPA Tunisia and NIOF Alexandria -in kind).

E. The sixth year of an ongoing assessment of the incidental catches of Loggerhead turtles on swordfish long lines in the Greek Ionian Waters was completed in 1994. It is run by Archipelagos in collaboration with the captains of up to eight vessels based on the island of Kefalonia. Turtles are caught in 25% of the fishing trips. Most commonly, one turtle is caught per long line but up to three have been recorded. A majority of turtles caught are juveniles (less than 75cm long). Vital size, sex and capture location data of the turtles is being recorded by the fishermen. The turtles are returned, invariably alive, with hooks still in their mouths, back to the sea. This project has been the perpetrator of a positive attitude towards the turtles by the otherwise impartial captains. (Archipelagos project, Co-financed by GAWF [UK], MEDASSET and Archipelagos).

MEDASSET ACTIVITIES 1990-1993

REFERENCES

KASPAREK M. 1991, Marine Turtles in Greece. Results of a Survey of Potential Nesting Beaches in the Northern Aegean. 160 pp. Unpubl. Report.
KASPAREK M. 1993, Marine Turtle Conservation in the Mediterranean : Marine turtles in Egypt. Survey of the Mediterranean Coast Between Alexandria and El Salum. Phase I. 74 pp. Unpubl. Report.
KASPAREK M. 1994, Marine Turtles in the Mediterranean : Marine Turtles in Syria. Survey of the Syrian Coast. 20pp. Unpubl. Report, available from MEDASSET.
PANOU A., ANTYPAS G., GIANNOPOULOS Y., MOURELATOS D., CH. & G., MOSCHONAS S., TOUMAZATOS P., TSELENTIS L., VOUTSINAS N. & VOUTSINAS V., 1992. Incidental catches of Loggerhead turtles, *Caretta caretta*, in Swordfish Long Lines in the Ionian Sea, Greece. B.C.G. *Testudo* 3(4) 47-57.
PANOU A. *et al.* 1989/90/91/93. Incidental Catches of Loggerhead Turtles, *Caretta caretta*, in Swordfish Long Lines in the Ionian Sea, Greece. Unpubl. Reports. Available from MEDASSET.
WITMORE C., JESU R. and REYNOLDS P., 1991, Sardinia. An Assessment of Beaches for Loggerhead Turtle Nesting. 50pp. Unpubl. Report. Available from MEDASSET.

V

IDENTIFICATION DE QUATRE BALEINOPTÈRES DE MÉDITERRANÉE OCCIDENTALE
CAMPAGNE OCEANOGRAPHIQUE (22 - 29 AVRIL 94). N/O GEORGES PETIT. CNRS INSU.

D. VIALE[1], N. TERRIS[1], J. ROCQUEFERE[2], E. PONSIN[2], M. FENOUILLERE[3], L.C. CAPITANI[3], N. VERNEAU[1]

[1] Université de Corse, CEVAREN BP 52, 20250 Corte, France
[2] CNRS AI 34915, URA 877, France
[3] Etablissement militaire - 20250 Corte, France

Tous les baleinoptères observés en mer ou échoués sur les côtes corses depuis 1965 ne dépassent pas les 22 mètres. La littérature ancienne fait état d'échouages de baleines de 25 mètres mais nous avons attribué cette différence de taille par rapport à la taille de nos échantillons à des erreurs de mesure ou des erreurs de conversions d'unités de mesure. Or, trois observations rapportées ici montrent l'existence d'individus de plus de 25 mètres.

Méthode. Mensurations d'une femelle échouée dans le golfe d'Ajaccio (Corse).

Campagne à la mer du 22 au 29 avril 1994 : cette mission conduite dans le Bassin Liguro-Provençal visait à marquer un rorqual (*Balaenoptera physalus*) avec une balise ARGOS. Ce programme nécessite une surveillance visuelle du point du jour au coucher du soleil. La technique de marquage par fixation de la balise dans l'aileron nécessite une stratégie d'approche très près de la baleine. Ainsi, l'observation de l'aileron est au centre des préoccupations de toute l'équipe.

Résultats

Observations à la mer : au cours des nombreuses approches des 18 baleines qui ont été comptées au total, quatre individus ont été identifiés par des indices sur l'aileron. La figure schématise ces indices; un des ailerons est entaillé par une blessure circulaire (1); un autre aileron porte une blessure triangulaire sur le bord externe (2); le troisième est reconnaissable par le fait que l'extrémité semble cassée et se rabat en arrière; la pointe de cet aileron a perdu sa rigidité et l'aileron ressemble davantage à un bonnet phrygien qu'à un aileron normal (3). Le quatrième spécimen a été identifié par "l'énormité" relative de sa taille par rapport aux autres ailerons (4). Le rorqual ainsi caractérisé était également d'une taille respectable mais qui n'a pu être évaluée avec précision. Cette observation a été faite à 42°31,3 Nord et 0,6° 12,8 Est .

Echouages : parallèlement deux échouages de *Balaenoptera physalus* ont été découverts dans la partie sud-ouest de la Corse. Un jeune baleinoptère est trouvé à la pointe sud du Golfe d'Ajaccio le 30.11.1993; il s'agit d'un nouveau né de 518 centimètres. Son cadavre est très frais, sans aucune marque externe, avec rigidité cadavérique conservée; l'estomac contient encore du lait épais et jaune. La mort remonte à moins de 24 heures. Les viscères semblent normaux macroscopiquement sauf le coeur hypertrophié, globuleux et les poumons très compacts et oedèmateux; de telles altérations ont été décrites par ailleurs (VIALE *et al.* 1992). L'histologie de ce rorqual est en cours (J.P. Frodello). Une femelle de plus de 25 mètres est trouvée échouée à la pointe nord du golfe d'Ajaccio le 05.03.1994. La mort est ancienne. Les muscles sont autolysés : l'anatomo-pathologie et l'histologie sont impossibles. L'aileron est de 45 centimètres de haut, il n'est pas aussi grand que celui de la figure 1 (4). La taille maximale du rorqual étant de 26 mètres il semble donc que cet aileron très développé soit une distinction originale allométrique de cet individu.

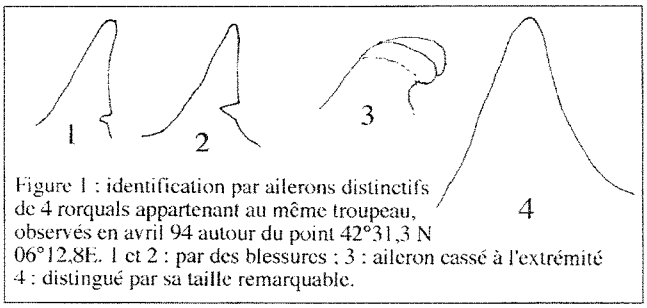


Figure 1 : identification par ailerons distinctifs de 4 rorquals appartenant au même troupeau, observés en avril 94 autour du point 42°31,3 N 06°12,8E. 1 et 2 : par des blessures ; 3 : aileron cassé à l'extrémité 4 : distingué par sa taille remarquable.

Discussion. Au cours de l'hiver et du printemps 1994 apparaissent donc deux spécimens de Baleinoptères de très grande taille dont une femelle dans le Bassin Liguro-Provençal. D'autre part, le cadavre d'un nouveau-né atteste de la reproduction de ces Baleinoptères en hiver en Méditerranée occidentale.

Comme JONSGÄRD (1966), nous pensons que ces rorquals appartiennent à une population qui vient hiverner et se reproduire en Méditerranée occidentale. Au printemps s'amorce une migration vers l'ouest (VIALE, 1995), c'est-à-dire vers le détroit de Gibraltar, et une remontée vers les zones Atlantique-Nord alors libérées des glaces. Jonsgärd étaye son hypothèse par l'étude de la composition des graisses provenant des baleines exploitées au nord de l'Ecosse, qui montrent une forte similitude avec la composition de celles des baleines exploitées de 1925 à 1929 dans le détroit de Gibraltar.

C'est pour vérifier cette hypothèse qu'a été réalisé le suivi par satellite d'une baleine marquée par une balise ARGOS. Cependant, ce suivi de septembre à novembre 1991 n'a pas conduit au détroit de Gibraltar. Une deuxième tentative en juin 1993 a été interrompue par rupture du filin porteur de la balise, sous l'action d'une autre baleine sans cesse accolée à la baleine appareillée.

Conclusion. L'expérience de suivi par satellite est donc encore à poursuivre. Dans cette attente, il paraît très utile de tenter de repérer les quatre baleines que nous venons de décrire, dont l'une est particulièrement surprenante et bien identifiable par la grosseur exceptionnelle de son aileron. Nous lançons un appel à tous les cétologues de Méditerranée et des côtes atlantiques françaises ainsi qu'à nos collègues du Royaume-Uni, plus particulièrement à ceux du nord de l'Ecosse, pour qu'ils soient vigilants.

Information à transmettre. Tél: +33 95.45.00.29 ou 95.33.26.52; Fax: +33 95.61.05.51.

REFERENCES

JONSGÄRD A. 1966 -Biology of the north Atlantic Fin whale: taxonomy, distribution, migration and food. *Hvalradets skrifter*, 40 : 62 p.

VIALE D., F. BAGAINI, S. FREMONT et A.M. ISETTI. 1992 -Etudes anatomo-pathologiques des cétacés échoués sur les côtes françaises de Méditerranée. Proceed. Symp. Whales : Biology-Threats-Conservation. Ed. Symoens, Royal Acad. of Overseas sciences (Brussels) : 173-185.

VIALE D. -Courbes du courant Liguro-Provençal marquées par la présence de grands cétacés. Campagne CNRS (22-29 avril 94). *Rapp. Comm. Int. Expl. Mer Médit.* 1995.

INTRASPECIFIC DIFFERENTIATION PHENOMENA IN THE *APHANIUS DISPAR*-SPECIES-FLOCK (TELEOSTEI : CYPRINODONTIDAE)

Wolfgang VILLWOCK[1] and Adolf SCHOLL[2]

[1] Univ., Zoologisches Inst. und Zoologisches Mus., M. Luther-King-Pl. 3, Hamburg, Germany
[2] Zoologisches Institut der Universität Bern, Baltzerstr. 3, 3012 Bern, Switzerland

The Aphanius dispar-group is divided into two different subspecies, *A. dispar dispar* and *A. dispar richardsoni*, respectively. While the nominate populations are distributed from the Siwa Oasis/Egypt in the West to and around the Arabian peninsula, the Gulf of Iran to salt pits near Karachi/Pakistan in the East, the *richardsoni*-subspecies is restricted to the Dead Sea region of Jordan and Israel.

Numerous F_1- (hatched from controlled single pairmatings in 25 liter aquaria), F_2- and F_n-hybrids (about 35 different progenies) all showed fertility in the females, but remarkable differences in the degree of gonadal development andstructure in males : Males of about 18 reciprocal *A. dispar dispar* interpopulation-crosses from 9 different origins showed more or less "normal" spermatogenesis, but the testes of hybrid-males between members of the different subspecies contained only a few tubules with ripe spermatozoa and many with different stages of meiosis, with spermatogenesis arrested before reaching "full maturity". Moreover, the different *A. d. dispar* x *A. d. richardsoni* F_1-males showed a reduced fecundity which means that only a few of them may successfully reproduce, the others remaining practically sterile. These results indicate that despite the genetic relationship between the two subspecies, there is already a high amount of incompatibility, supposingly caused by the progessive development of substitution genes and transfer of gene-functions (KOSSWIG, 1947) which may induce sterility on a lower structural level e.g. non-completing spermhistogenesis, different types of hybrid-male sterility, etc. (VILLWOCK, 1964,1982).

These results coincide with results of some investigations of enzyme-patterns, reflecting similar "borders" of intraspecific differentiation. Investigations on 20 different enzyme loci of 8 geographically distant (=separated) *A. d. dispar* populations and the Ain Faskha-population of *A. d. richardsoni* from the Israel border of the Dead Sea show more similarity in allele frequencies among the *A. d. dispar* populations group than among these populations and *A. d. richardsoni*. Such similarities or differences have already proved valuable for population and species discrimination in the past : see the material & methods in SCHOLL *et al.* (1978), VILLWOCK *et al.* (1983).

All these investigations confirm both, the common origin of the *A. dispar* species-flock and the different historical stages of their separation in at least two subspecies (the "sister species" of *A. sirhani* [VILLWOCK *et al.*, l.c.] may easily be integrated in this part of the discussion). According to KRUPP (1983) the *A. dispar* ancestors inhabited coastal regions of the old marine, middle-miocene transgression of present Mesopotamia. Their distribution from there started most probably in the end of the miocene or in the beginning of the pliocene. During pleistocene/holocene times, the separation of the *A. dispar* species-flock into separated but still large populations took place such that a bigger one reached the Jordan - Dead Sea valley, which later became a freshwater lake, named Lake Samra, that covered the rift valley from south of the present Dead Sea to the north of recent Lake Tiberias. Thereafter, Lake Samra shrunk and developed into the brackish Lake Lisan. Towards the end of the third interpluvial period (called interpluvial C) Lake Lisan itself dried up by desertification so that the existing fish fauna, e.g. *Aphanius dispar*, were forced to move into the remaining bodies of freshwater around the developing Dead Sea. Isolated from the main populations since postglacial times, the Dead Sea *Aphanius dispar* started its development into the recent *A. dispar richardsoni* populations. The setlement of the southeastern Mediterranean by other *A. dispar* populations probably started already during the eustatic fluctuations of the sea-level during the different interpluvial times, passing the region of the Gulf of Suez and one arm of the old Nile estuary. All of these historical suggestions support the abovereported conclusions of a close genetic relationship on the one and the beginning genetic separation on the other, long and welldescribed as species *in statu nascendi*.

REFERENCES

KOSSWIG C., 1947. Über Substitutionsgenc und Transfer der Genfunktion. *Experientia*, 3 : 401-410.

KRUPP F., 1983. The freshwater fishes of Saudi Arabia and adjacent countries. *In* : Fauna of Saudi Arabia, 5: 568-636.

SCHOLL A., CORZILLIUS B. und W. VILLWOCK, 1978. Beitrag zur Verwandtschaftsanalyse altweltlicher Zahnkarpfen der Tribus Aphaniini (Pisces, Cyprinodontidae) mit Hilfe elektrophoretischer Untersuchungsmethoden. *Z. zool. Syst. Evolut.-forsch.*, 16 : 116-132.

VILLWOCK W., 1964. Genetische Untersuchungen an altweltlichen Zahnkarpfen der Tribus Aphaniini (Pisces: Cyprinodontidae) nach Gesichtspunkten der Neuen Systematik. *Z. zool. Syst. Evolut.-forsch.*, 2 : 267-382.

VILLWOCK W., 1982. Aphanius (NARDO, 1827) and Cyprinodon (LAC., 1803) (Pisces: Cyprinodontidae), an attempt for a genetic interpretation of speciation. *Z. zool. Syst. Evolut.-forsch.*, 20 : 187-197.

VILLWOCK W., SCHOLL A. und F. KRUPP, 1983. Zur Taxonomic, Verbreitung und Speziation des Formenkreises *Aphanius dispar* (RÜPPELL, 1828) und Beschreibung von Aphanius sirhani n.sp. (Pisces: Cyprinodontidae). *Mitt. hamb. zool. Mus. Inst.*, 80 : 251-277.

V

LENGTH BASED METHODS FOR DETERMINATION OF GROWTH PARAMETERS BY SEX IN *MULLUS BARBATUS*

A. VOLIANI, A. ABELLA, R. AUTERI

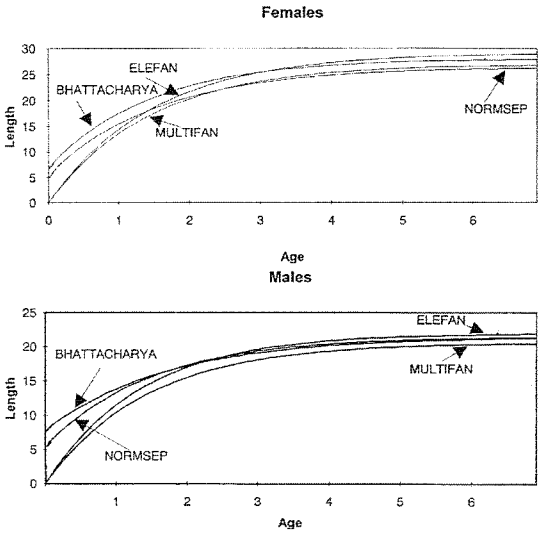
Consorzio Regionale di Idrobiologia e Pesca. Livorno, Italy

The different individual growth pattern for males and females in a number of species of Osteichthyes, makes it difficult to use the analysis of the progression of modal classes to determine the parameters of the Von Bertalanffy growth curve. As a matter of fact when algorithms like those included in MULTIFAN (FOURNIER *et al.*, 1990) or in the Compleat ELEFAN (PAULY, 1987) are used for the comprehensive frequency distributions of these species, the program can easily misinterpret the alternation of the two sex modes as a succession of year classes, thereby giving the impression that growth is much slower than it really is. In the case of *Mullus barbatus*, furthermore, the presence of several false rings in the otoliths (VRANTZAS *et al.*, 1992) makes it difficult to use them for growth studies; misidentification of annual rings can bring to an understimate of the K parameter in the growth curve. These causes, as well as possible discrepancies in growth patterns of different geographical areas, can have produced the high variability in the estimates of growth parameters for red mullet by different authors.

All specimens of *Mullus barbatus* caught during 13 trawl surveys were measured in their total lengths divided by sex. In order to avoid any possible bias in the size distribution caused by the selectivity of the fishing instrument, a cover was used particularly in the species recruitment periods (AUTERI and RIGHINI, 1979; ORSI RELINI and ARNALDI, 1986). Sex determinations were always done on fresh specimens, without recourse to freezing, so as to increase the possibility of sex identification in resting periods as well as in small size individuals. This strategy drastically reduced the frequency of sex-undetermined individuals. Summer samples included massive quantities of undeterminable small recruits (TL < 10 cm); for these young individuals, considering that sexual differences on mean length were negligible, an even distribution of 50% between the two sexes was made. Data were processed with the above mentioned programs MULTIFAN and ELEFAN, both of which make direct use of size distributions to prepare an estimate of the growth parameters. In order to separate the modal classes, the program NORMSEP (ABRAMSON, 1971) and the Bhattacharya method of the program LFSA (SPARRE, 1987) were utilized. Modes were easily aged because the species' reproduction time is known (ORSI RELINI and ARNALDI, 1986). The couples of data obtained with both methods were then used as input for the program ETAL (GASCHUETZ *et al.*, 1980) for alternative estimates of the growth parameters. Results are shown in the following table.

	FEMALES				MALES			
	L_∞	K	t_o	ϕ'	L_∞	K	t_o	ϕ'
ELEFAN	29.2	.68		2.76	22.0	.74		2.55
MULTIFAN	27.0	.70		2.71	20.6	.70		2.47
BHATTACHARYA+ETAL	28.1	.69	-.42	2.74	21.5	.58	-.78	2.43
NORMSEP+ETAL	26.5	.64	-.37	2.65	21.5	.67	-.44	2.49

As the rare Winter surveys would make improbable a good fitting of seasonal growth curves, this hypothesis was not considered even when the program could have calculated them. The results obtained with the four different approaches for each sex are very similar as can be seen in the figures where the four curves for males and females have been drawn and by the comparison of the PAULY and MUNRO (1983) ϕ' values. Whichever curve is analyzed, a rapid growth for the species is observed, faster for females which present a larger size; this fast growth rate is in agreement with the results of PASSELAIGUE (1974), GHARBI and KTARI (1981), VRANTZAS *et al.* (1992). A useful mention must be made about the important consequences that a rapid growth performance can bring regarding the exploitation strategy of this important fishery resource, especially in relation with the application of theoretic assessment models.



REFERENCES

ABRAMSON N.J., 1971. Computer programs for fish stock assessments. FAO Fish. Tech. Paper, 101.

AUTERI R. & RIGHINI P., 1979. Studio dei rendimenti di pesca e delle condizioni faunistiche dei fondi a strascico antistanti la costa della Provincia di Livorno. Centro Provinciale Studi sulla Pesca. Provincia di Livorno. 60 p.

FOURNIER D.A., SIBERT J.R., MAJKOWSKI J. & HAMPTON J., 1990. *Can. J. Fish. Aquat. Sci.* 47 :301-317.

GASCHUETZ G., PAULY D. & DAVID N., 1980. Int. Counc. for Expl. Sea.

GHARBI H. & KTARI M.H., 1981. *Bull. Inst. natn. scient. tech.Océanogr. Pêche* Salammbo. 8: 5-40.

MUNRO J.L. & PAULY D., 1983. ICLARM *Fishbyte*, 1(1) : 5-6.

ORSI RELINI L. & ARNALDI D., 1986. Note di biologia della triglia di fango, *Mullus barbatus* L. 1758,del Mar Ligure; riproduzione e reclutamento. *Boll. Mus.Ist. Biol. Univ. Genova* 52 suppl.:237-250.

PASSELAIGUE F., 1974. Etude comparée de la croissance de quelques poissons Téléostéens du Golfe de Marseille. Thèse 3e cycle (158 pp). Univ. Aix-Marseille II.

PAULY D., 1987. ICLARM Conference Proceedings 13, 468 p.

SPARRE P., 1987. FAO Fish. Tech. Pap. (101): suppl. 2 : 218.

VRANTZAS N., KALAGIA M. E., KARLOU C., 1992. FAO Fisheries Report. N° 477 : 51-67.

INDEX ALPHABÉTIQUE DES AUTEURS*

** Seuls les premiers auteurs des communications présentées au XXXIVe Congrès de la CIESM figurent dans cet index*

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

R

S

T

U

V

W

Y

Z